Compressed Air Magazine

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APRIL, 1928

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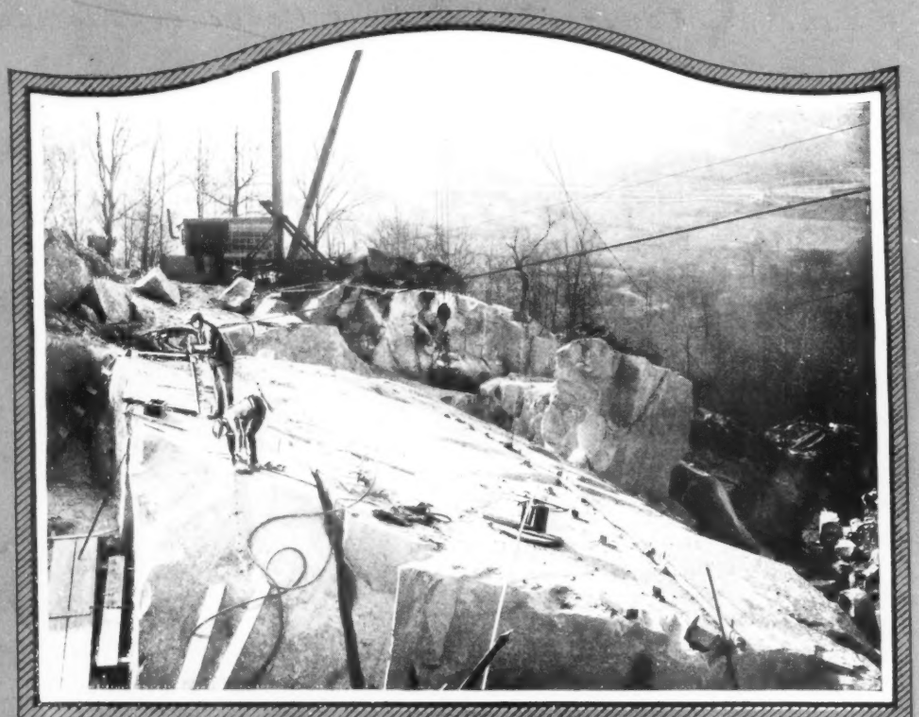

PLUGS AND FEATHERS USED TO GET OUT BIG BLOCKS OF GRANITE FOR THE GREAT CATHEDRAL OF ST. JOHN THE DIVINE IN NEW YORK CITY

How Hickory Handles For Tools Are Made
Allen S. Park

World's Deepest Gold Mine, in South Africa
Owen Letcher

Getting Out Stone for a Great Cathedral
R. G. Skerrett

Guernsey Dam Helps Irrigate North Platte Valley
C. H. Vivian

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n-744-L

Waukesha-Powered Link Belt Crane in Florida

In the Land of Sunshine

Throughout the Florida Boom, Waukesha-equipped shovels and cranes could be found from Miami to St. Petersburg. They prove their unfailing reliability in digging oyster shells, quarrying coral rock, building canals and making roads. We have many reports ranging from four to fourteen months of continuous operation that indicate why contractors who have had experience with Waukesha engines in the past always want them on their new equipment.

On the job shown above this clam shell handled over 100 yards an hour on a consumption of fuel averaging about 3¼ gallons per hour. Waukesha 100 H. P. Heavy-Duty type engines, such as used in these cranes, are giving 24-hour service week after week and because of the "Ricardo Head" give more power with less fuel. Remember this—if you were at the Good Roads show in Cleveland, you probably saw the new model Waukesha Heavy-Duty Industrial engine designed especially for cranes, power shovels and other construction machinery. If you were not there write for Bulletin No. 581.

N-796-L

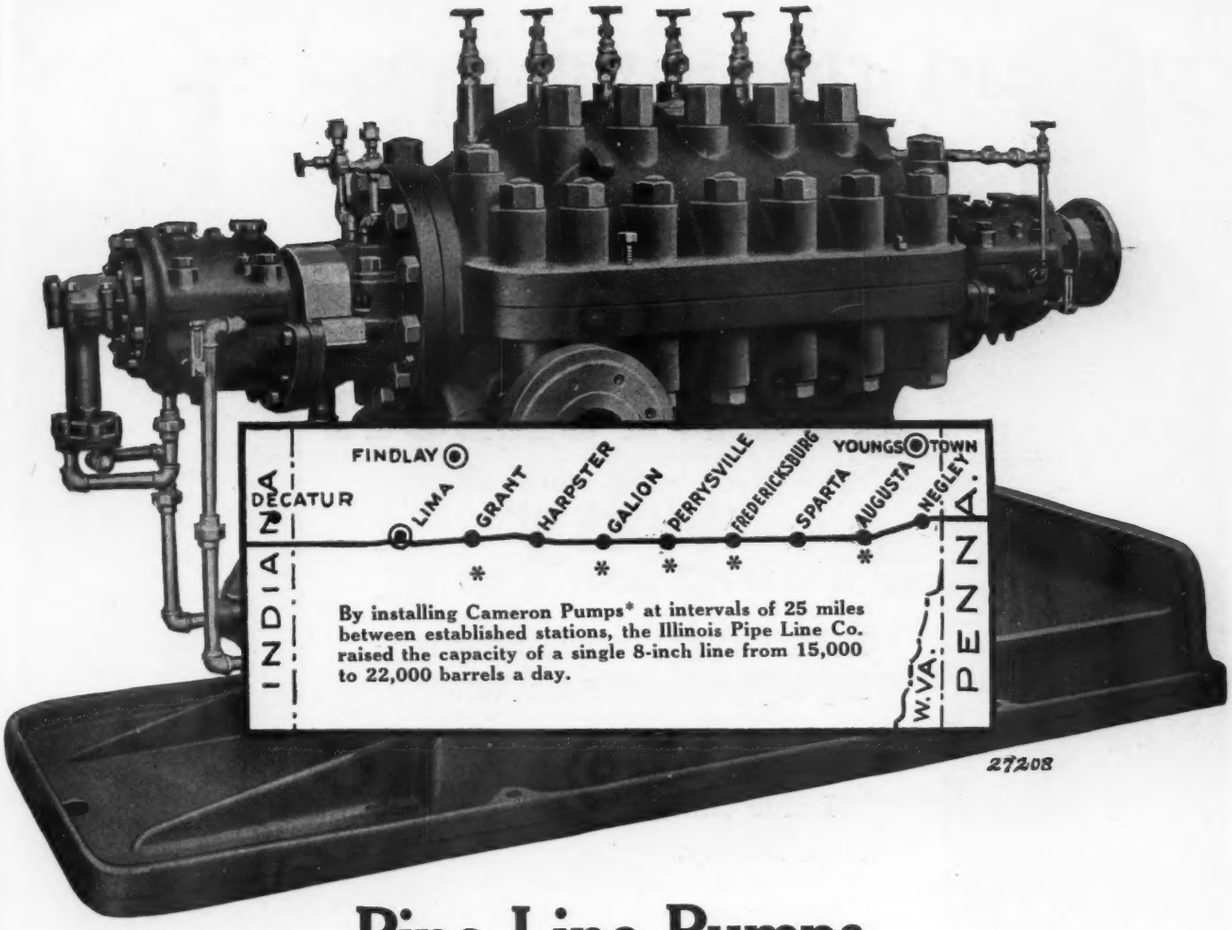
INDUSTRIAL EQUIPMENT DIVISION

WAUKESHA MOTOR COMPANY

Waukesha Wisconsin

New York	Kansas City	Denver	Tulsa	Houston	San Francisco
8 *W. 40th Street*	*V. L. Phillips Co.*	*Wilson Machy. Co.*	*C. F. Camp Co.*	*Portable Rig Co.*	*C. A. Watts*

Exclusive Builders of Heavy-Duty Gasoline Engines for Over Twenty Years



Pipe Line Pumps

THE USE of Cameron electric-motor-driven Centrifugal Pipe Line Pumps results in a greater volume of oil being moved per day. Some of the points of superiority of these sturdy and efficient units over other types of pumping plants are as follows:

1. Emulsification is avoided through their use.
2. They serve to prevent injurious surges and pulsations in the line.
3. They cost less to install than direct-acting steam pumps and do not need large buildings and storage tanks.
4. Their maintenance cost is small. Stand-by losses are lower than those of steam pumps.
5. Centrifugal pumps and electric motors can be assembled or disassembled rapidly, and shipped easily. This mobility is an important feature.
6. They require fewer men in attendance than do steam pumps.

Cameron Centrifugal Pipe Line Pumps, which are the result of extensive experimental work on the part of the Ingersoll-Rand Company, are more than equal to any demands that might be made upon them in this exacting field of service in the oil industry.

A. S. CAMERON STEAM PUMP WORKS, 11 Broadway, New York City

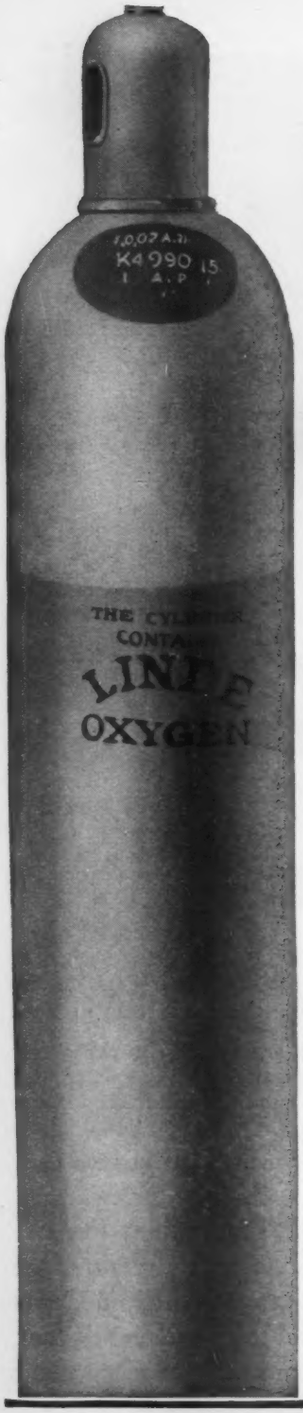
Offices in principal cities the world over

CANADIAN INGERSOLL-RAND CO., LIMITED
10 PHILLIPS SQUARE, MONTREAL, QUEBEC

INGERSOLL-RAND CO., LIMITED
165 QUEEN VICTORIA STREET, LONDON, E. C. 4

294-DV

Cameron Pumps



There must be a good reason why

Linde Oxygen is the largest selling oxygen on the market.

There is.

Linde customers get more for their money.

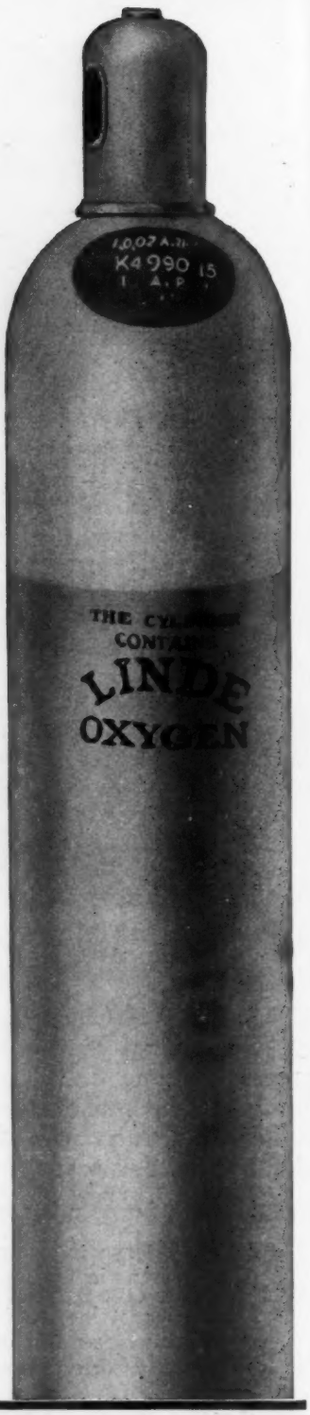
They get a good product, immediate delivery, and Linde Process Service that insures economical results.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: Carbide and Carbon Building
30 East 42d Street, New York

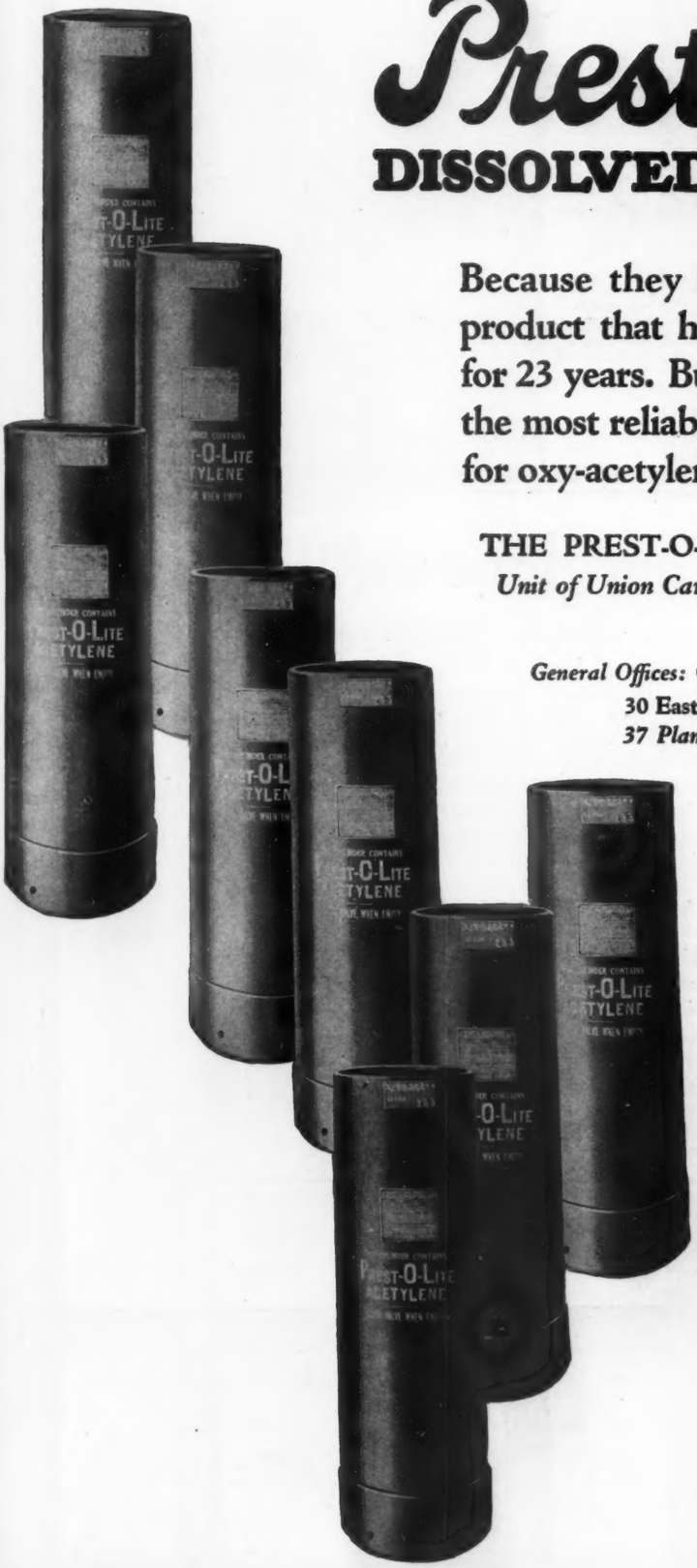
47 PLANTS . . . . . 105 WAREHOUSES



LINDE OXYGEN

People keep right on buying

Prest-O-Lite
DISSOLVED ACETYLENE



Because they have confidence in a product that has been manufactured for 23 years. But mainly because it is the most reliable and economical fuel for oxy-acetylene welding and cutting.

THE PREST-O-LITE COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: Carbide and Carbon Building
30 East 42d St., New York
37 Plants—102 Warehouses

Keeping out poor welds

The best welds can be made only with the best welding rod. It is a plain case of metallurgy.

That's why Oxweld welding rod is manufactured to meet rigid specifications. Not only is chemical analysis specified but actual welding tests are made with every lot of rod before it is stamped with the Oxweld trademark.

OXWELD ACETYLENE COMPANY

Unit of Union Carbide and Carbon Corporation

NEW YORK CITY, 30 E. 42d St. UCC STOCKS IN 41 CITIES

CHICAGO, 3642 Jasper Place SAN FRANCISCO, 8th & Brannon Sts.

IN CANADA, Dominion Oxygen Company, Ltd., Toronto

Oxweld

WELDING AND CUTTING APPARATUS

PROTECTOMOTOR

REG. U. S. PAT. OFF.

Perfect Positive Protection

Industrial Air Filters

Are the most practical for every size and type of machine.

Simplicity of design, highest efficiency—99 9/10%, durability, freedom from attention and the fact that all models are shipped complete in weather proof housings with threaded or flanged connections accounts for the sale of

Over 250,000 In the Past 5 Years

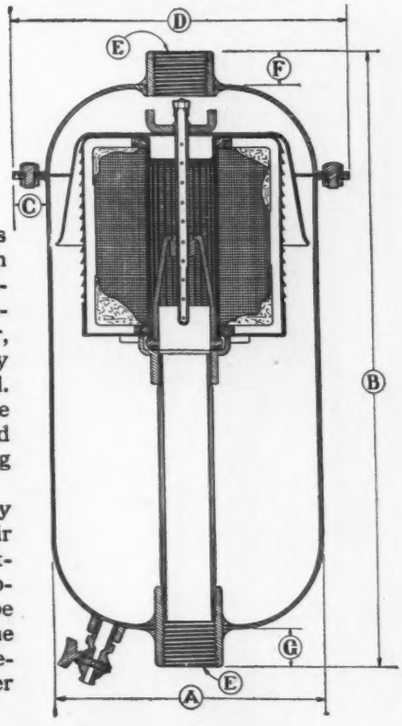
An Outstanding Achievement

The Model CP Pipe Line Filter is far superior to the traps or separators on the market in that it provides a positive high efficiency filter, in addition to the inertia or centrifugal principle of separation. Complete removal of all water, oil, iron rust, pipe scales and any other foreign matter is accomplished. A most important feature is that the filtering medium may be cleaned quickly and thoroughly by reversing the flow of the air.

These filters will deliver clean dry air for paint spraying, compressed air tools, hoists, cleaning operations, agitating liquids, ice-making, chemical processes, etc. We have made this type of filter as special equipment for the past three years. The increasing demand has made it desirable to offer them in the range of sizes shown.

Sectional View of the Model CP Pipe Line Filter

Cross Section Pipe Line Filter



Specifications of Model "CP" Pipe Line Filters

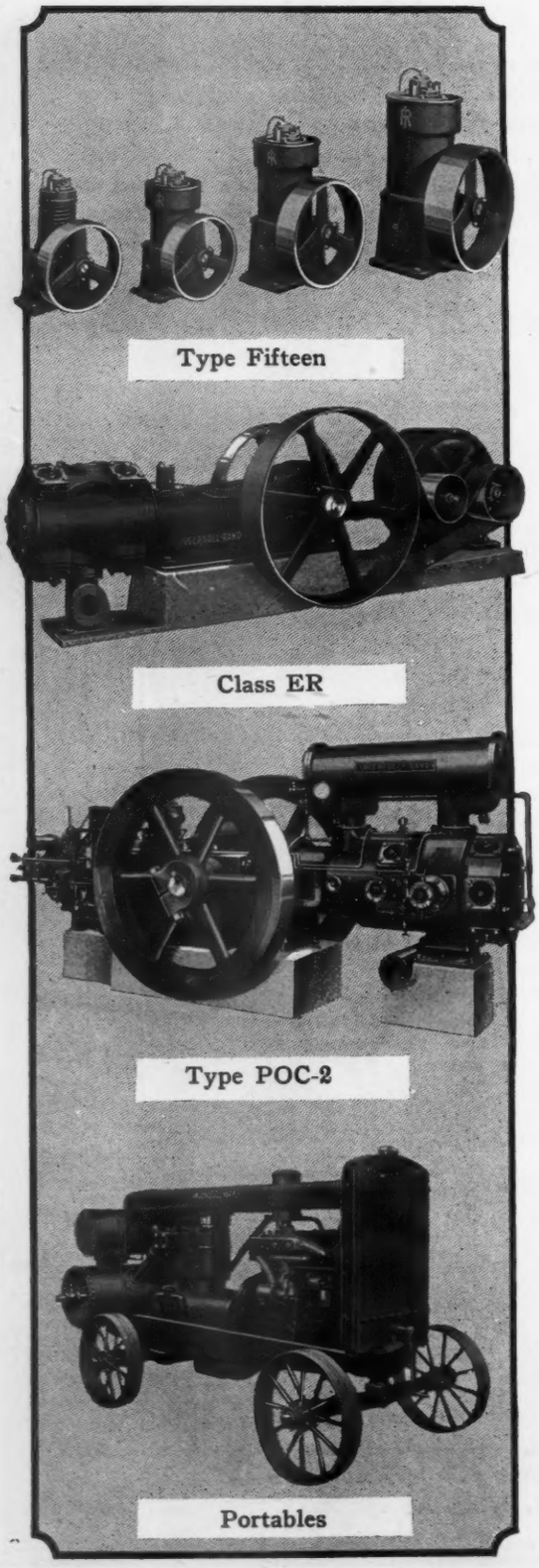
Size	A	B	C	D	E (Briggs)	F	G
CP-0	5"	11½"	¾"	6¾"	¾" S. P.	7/16"	13/16"
CP-1	6"	13 11/16"	¾"	7¾"	1 " S. P.	½"	15/16"
CP-2	7"	15 15/16"	¾"	8¾"	1½" S. P.	½"	1 3/16"
CP-4	8"	18 1/16"	¾"	9⅞"	2 " S. P.	½"	1 5/16"
CP-4A	9"	20 5/16"	¾"	10⅞"	2½" S. P.	⅝"	1 7/16"
CP-5	10"	22 7/16"	¾"	12 "	3 " S. P.	⅝"	1 9/16"

(Catalogue showing complete line on request)

STAYNEW FILTER CORPORATION

ROCHESTER, N. Y, U. S. A.

1000 I-R Compressors



COMPRESSED air is being put to new uses every day—uses where it speeds up operations, lowers labor costs, and produces superior work.

The efficiency and economy of air depend upon its source—the compressor. The surest way you can get real compressor value is to buy a machine with a reputation based on long years of successful performance. Ingersoll-Rand Compressors have this enviable distinction wherever air is used.

Some Standard Compressor Models

(Capacities listed below are for 80 to 100 pounds discharge pressure except where otherwise noted. These and other types are also furnished for lower and higher discharge pressures.)

Type Fifteen—

Vertical, single-stage, single-acting type, with automatic, constant-level, positive-flow lubrication. Suitable automatic unloaders for any kind of service. Can be furnished direct-connected to motor, equipped for long or short belt drive, or furnished with tight-and-loose pulleys.

Capacities, 7 to 23 cu. ft. per minute.

Class ER-1 and FR-1—

Straight-line, single-stage, double-acting; dust-proof, enclosed construction; automatic lubrication; I-R plate-type inlet and discharge valves; reliable automatic regulators for every size. The ER-1 is recommended for short-belt drive. The FR-1 is steam-driven. It has balanced piston steam valves which give unusually high steam economies.

Capacities, 28 to 528 cu. ft. per minute.

Type POC-2—

Straight-line, two-stage compressor, direct-connected to single-cylinder, solid-injection, four-cycle Type "PO" Oil Engine. Automatic by-pass control for unloading the compressor.

Capacities, 350, 600, and 900 cu. ft. per minute.

Portables—

Vertical, duplex, single-acting compressor, direct-connected to 4-cylinder, 4-cycle, tractor-type gasoline engine, or to electric motor. Assembled on cast-steel frame and arranged for many types of mountings.

Seven sizes available.

I-R Compressors can be furnished with cylinder combinations for many special pressure conditions.

Are Ready to Serve You

NO matter what your compressed air needs are, you will find an I-R machine to fit them. There are more than 1,000 sizes and types to choose from —a range of machines that will compress air from one pound to more than 4,500 pounds pressure.

I-R Compressors operate directly by steam, electric motor, or oil engine; or they may be had arranged for belt drive. They are available in capacities from 7 to 10,000 cubic feet per minute.

Imperial Type XPV—

Duplex, two-stage, dust-proof, enclosed construction; automatic lubrication; balanced piston steam valves with automatic cut-off governor for regulation. Suitable for either saturated or superheated steam, condensing or non-condensing.

Capacities, 647 to 1955 cu. ft. per minute.

Imperial Types XRB-2, XCB-2 and XRE-2—

Cross-compound, duplex units; dust-proof construction; automatic lubrication. The XRB-2 and XCB-2 have a belt wheel mounted on the compressor shaft. The XRE-2 has a synchronous motor direct-connected to the shaft. The XRB-2 has the "Imperial" intake and discharge unloader; the XRE-2 and XCB-2 use the patented 5-stage clearance control.

Capacities, 610 to 1505 cu. ft. per minute.

Class XOB-2—

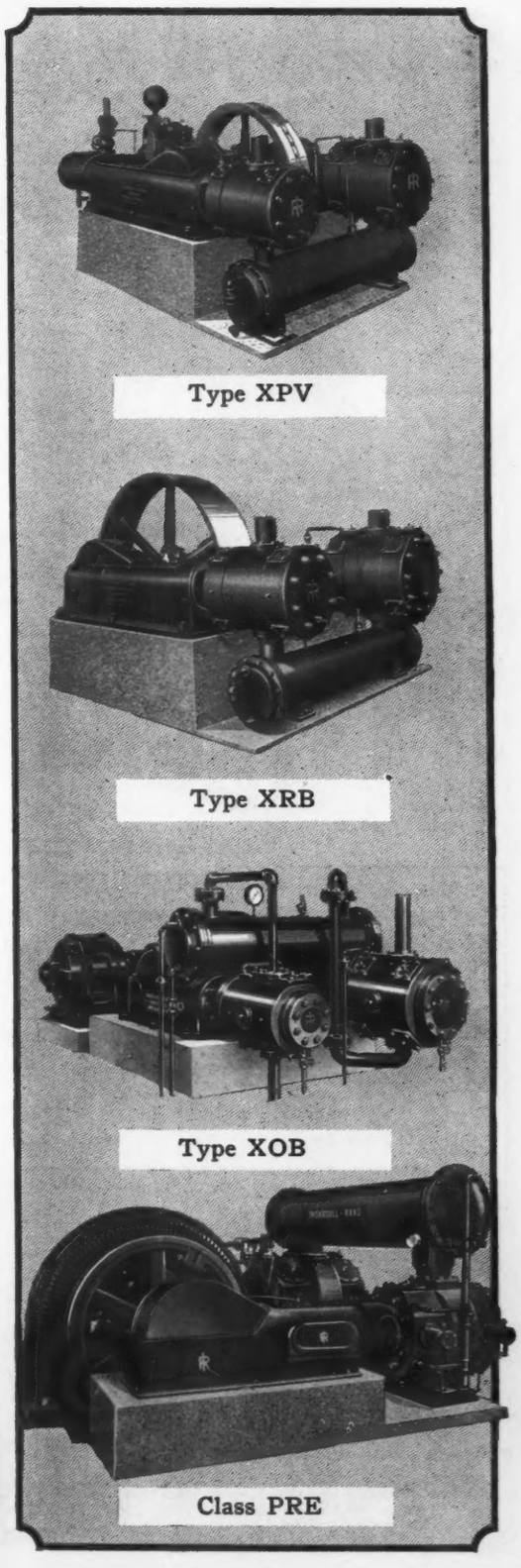
Duplex, two-stage construction; I-R plate-type valves; automatic lubrication. Designed especially for gas lift and air lift service in the oil fields.

Pressures up to 1,000 pounds.

Class PRE-2—

Duplex, two-stage, dust-proof, enclosed construction; direct-connected to synchronous motor; automatic lubrication; automatic 5-step clearance control regulation.

Capacities, 1302 to 7440 cu. ft. per minute.



Type XPV

Type XRB

Type XOB

Class PRE

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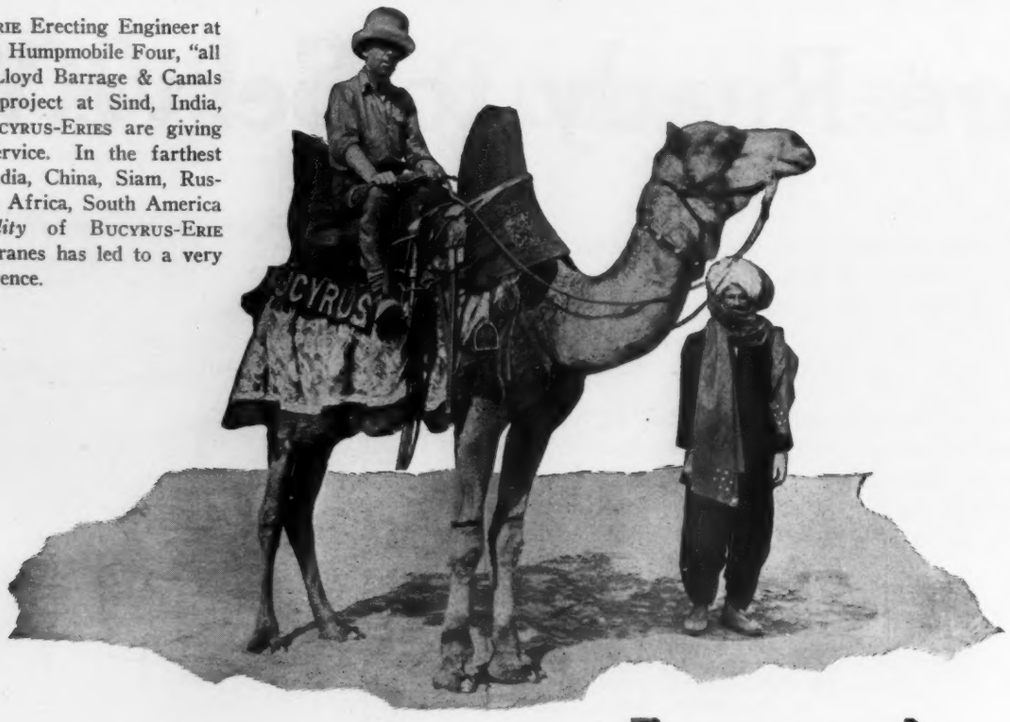
Ingersoll-Rand Co., Limited, 165 Queen Victoria Street, London, E.C. 4

902-C

Ingersoll-Rand

BUCYRUS-ERIE Erecting Engineer at the wheel of a Humpmobile Four, "all set" for the Lloyd Barrage & Canals Construction project at Sind, India, where 35 BUCYRUS-ERIES are giving remarkable service. In the farthest corners of India, China, Siam, Russia, Australia, Africa, South America —the *reliability* of BUCYRUS-ERIE shovels and cranes has led to a very natural preference.



Does your shovel meet the "Camel-back" test?

Maybe you have never worked a shovel at the far side of a desert —where any repair parts would have to be carried "camel-back." If you did, you'd certainly be careful to pick a reliable shovel for that job!

But why not choose just as carefully for EVERY shovel job? Even if your work is right smack up alongside of a railroad, extra repairs mean added cost—and what's far more expensive than the parts, LOST TIME.

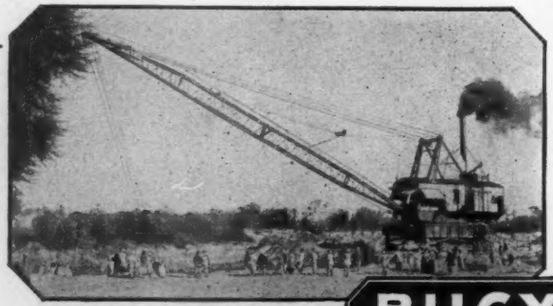
In any location, the shovel or crane you can depend on to Stand Up and Produce is the profitable machine to use.

Which explains why BUCYRUS-ERIE shovels and cranes are leaders in the faraway places, as well as throughout the U. S. A.

These machines are built with *Reliability* as the first consideration. Simple design, extra rugged construction, with plenty of the right steels where extra strength counts most—assuring you a machine that does a bigger day's work and *gets the work done.*

A Union of Strength

"BUCYRUS" and "ERIE" — each the most successful manufacturer in its particular field — consolidated Jan. 1, 1928. The unmatched resources of BUCYRUS-ERIE assure the buyer of Unequalled Value, More Efficient Machines, Permanence of the Manufacturer, and a More Complete Field Service.



One of 35 BUCYRUS-ERIES at work on the Lloyd Barrage & Canal Construction project at Sind, India.

BUCYRUS-ERIE COMPANY

South Milwaukee, Wis. Erie, Pa. Evansville, Ind.

BUCYRUS ERIE

Branch Offices:

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Ingersoll-Rand Air line lubricator used with DCR-23 Jackhammer.

Waugh air line oiler lubricating a Gardner-Denver airdrill.

For *Resistance to Oil* . . . "COMMANDER" AIR HOSE!

"COMMANDER"
The de luxe air drill hose. Oil-proof tube; extra-heavy braided cord reinforcement; double thickness, self-armoring cover.

"TYPE 50"
Tough and strong, yet light and easily handled. For pneumatic tools and light air drill service. Oil-resisting tube; multiple braided reinforcement.

"TYPE 88"
A wrapped construction air hose built of the same high-quality materials as "Commander."

Even if you use "line oilers" to lubricate your air drills, you'll find "Commander" standing up to its work months after ordinary air hose has given out.

The inner tube is a special oil-resisting rubber compounded to withstand the action of the most malignant mineral oils, which retains its strength from two to five times as long as ordinary rubber.

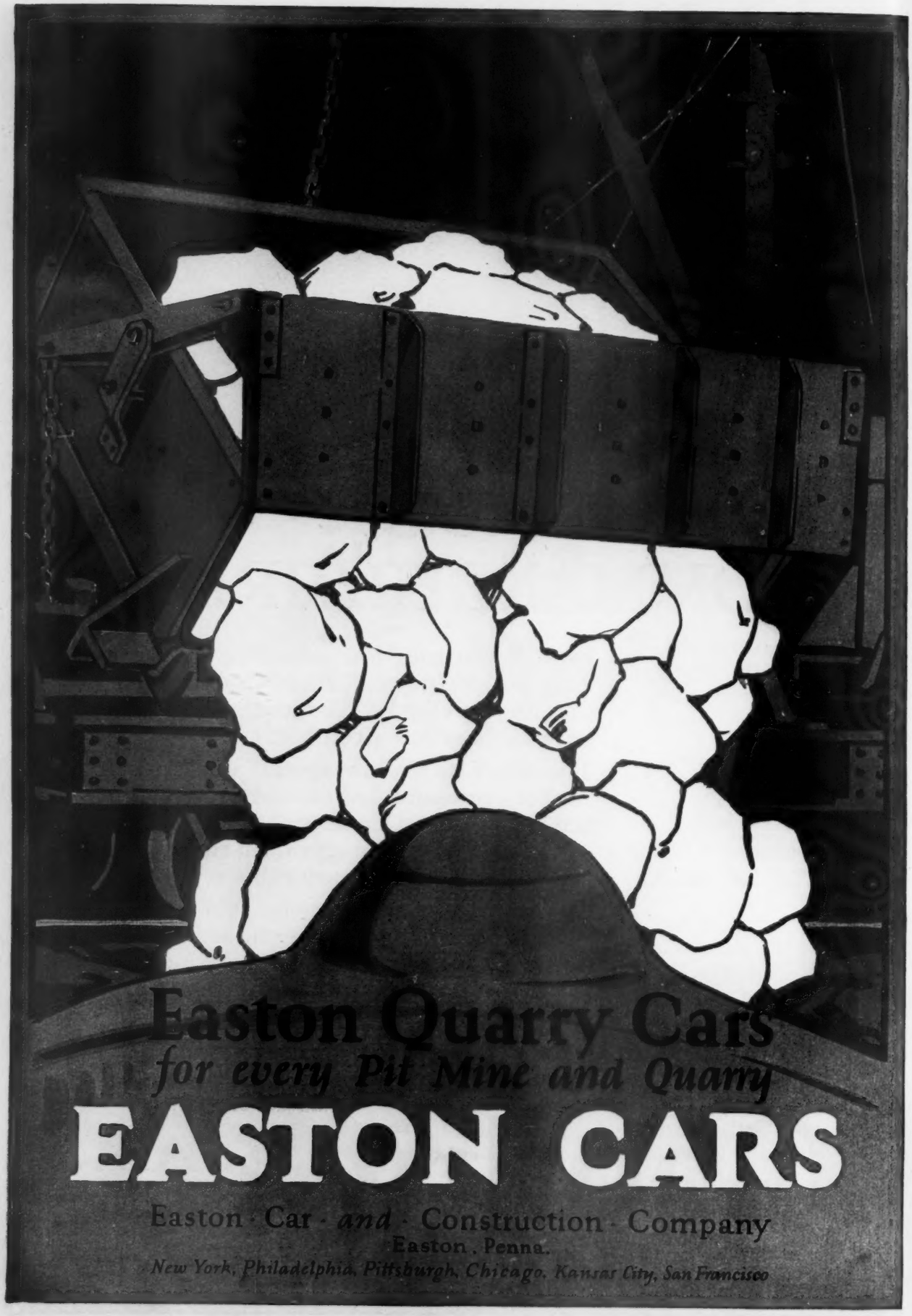
The cover is tough, brawny rubber, 50% stronger than you find on ordinary air hose —it will outwear any kind of steel armoring.

For lowest ultimate cost — Goodrich "Commander" Air Hose!

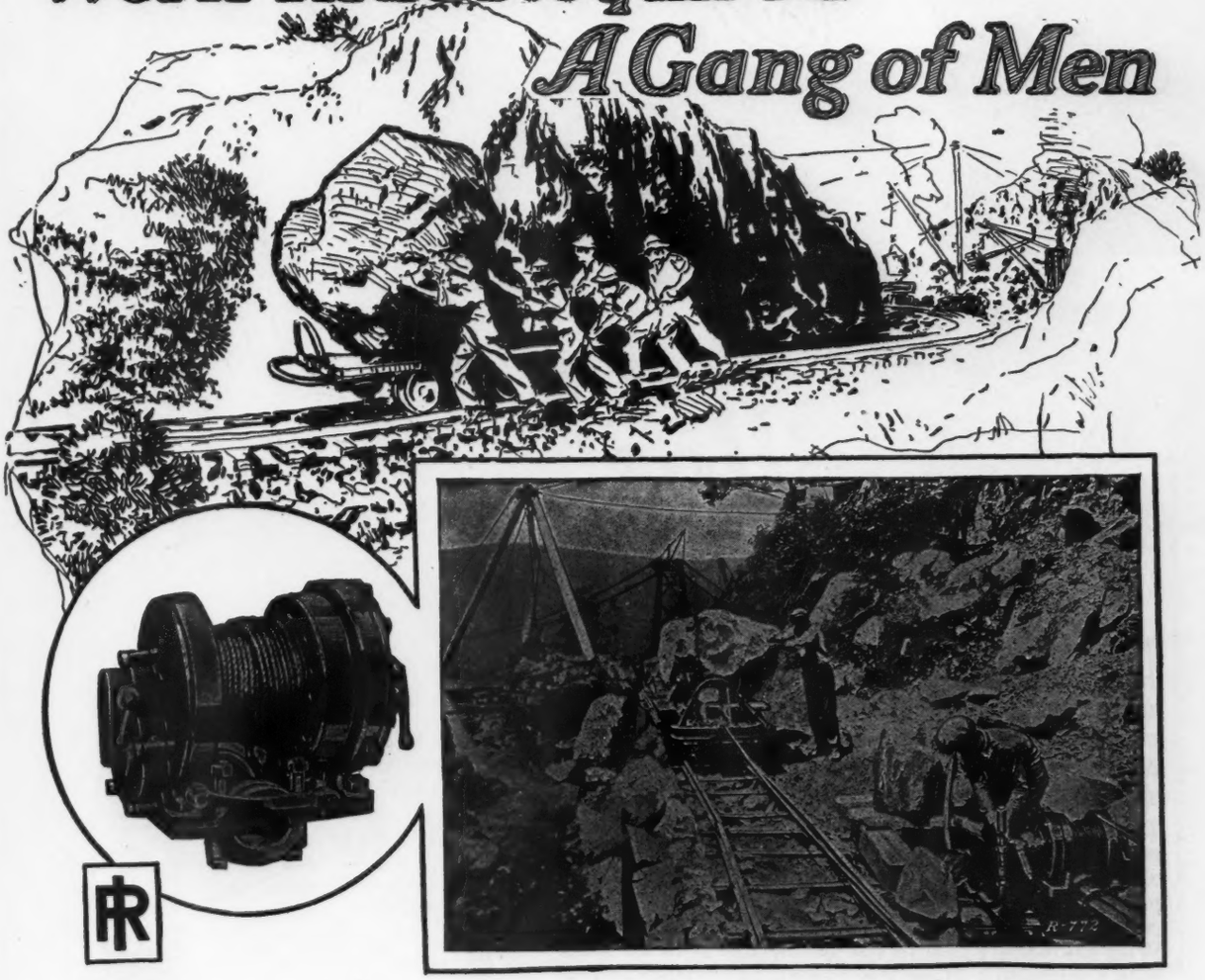
THE B. F. GOODRICH RUBBER CO.
Established 1870 Akron, Ohio

Goodrich AIR HOSE

"Type 50" "COMMANDER" "Type 88"


Easton Quarry Cars
for every Pit Mine and Quarry
EASTON CARS
Easton · Car · and · Construction · Company
Easton, Penna.
New York, Philadelphia, Pittsburgh, Chicago, Kansas City, San Francisco

Work That Required A Gang of Men



ON construction work, the 10H "Little Tugger" Hoist can be depended upon to move the heavy loads that ordinarily require a gang of men.

Around any job where material is hoisted or hauled, one of these 10H "Little Tuggers" will find a thousand uses. It saves time and money, and speeds up the work.

"Little Tugger" Hoists, made in three sizes, can be obtained with either single- or double-drum construction. They are available in both one-way and reversible types, and can be operated on either steam or air.

"Little Tuggers" are powerful machines, yet are easy to move about and set up. Put one on your job and watch results.

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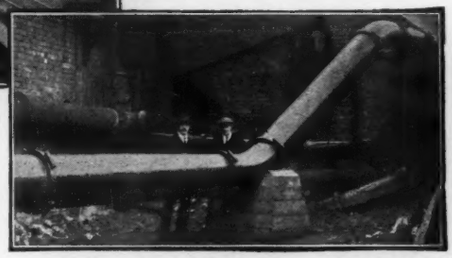
Ingersoll-Rand

Emergency 10" rising main installed in mine shaft

12" oil line

22" circulating line for condenser plant



Use Victaulic Couplings

and the Line will stay tight

VICTAULIC Couplings are all-purpose pipe couplings for oil, gas, water, sewage and compressed air lines. They have set new standards for strength and flexibility, for ease, speed and economy of installation.

They connect pipe as positively as flanged joints. Every coupling allows pipe deflection in any direction whether under pressure or vacuum. Victaulic Couplings take care of contraction and expansion of adjoining pipe lengths and GIVE A STRAIN-FREE LINE that stays leak-proof under severe vibration, pressure shocks and line sag. Maintenance costs are practically eliminated.

Lines can be installed faster, more easily and more economically when you use Victaulic Couplings. Faster, because it takes only a minute or two to connect pipes with Victaulic Couplings—tighten two bolts and the joint is made. More economically because all the work can be done by cheap, unskilled labor and because pipe for Victaulic Couplings costs less.

Victaulic Couplings are equally suitable for temporary lines and for permanent lines. They provide leak-proof joints which will outlast the pipe on which they are installed. Leading companies in all parts of the world use Victaulic Couplings on their oil, gas, water, and air distribution lines.

Victaulic Couplings are available for steel, wrought iron and cast iron pipe in all sizes from ¾ inch up, for all working pressures from vacuum to ten tons per square inch.

For every joint on the line *All-purpose couplings*

VICTAULIC COMPANY OF AMERICA

26 Broadway New York

FLEXIBLE LEAK-PROOF

VICTAULIC

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PIPE COUPLINGS

For detailed information and list of uses and users, tear off and send the coupon

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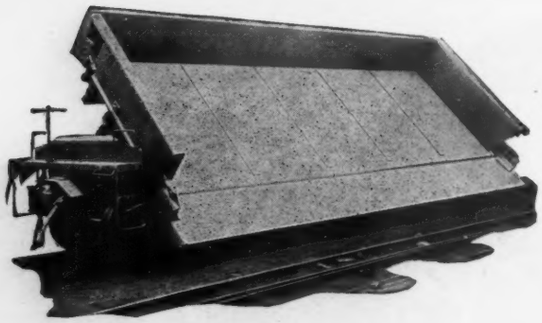
Name.....

Address .....

FOR OIL, GAS, WATER, SEWAGE, COMPRESSED AIR, ETC.

The Single Stroke Cylinder Car in Dumped Position



Western Dual Side Pivot Drop Door Air Dump Car

Below—
The single stroke cylinder—car in dumped position

Some Advantages of Single Stroke Cylinders

The Western Dual Side Pivot Drop Door Dump Car is dumped by single stroke air cylinders. These have the advantage of raising the body of the car in a continuous motion without pause. At the end of the stroke a short throw or kick gives the load added momentum at the moment of discharge, giving fast, *clean* dumping without shock of impact.

The thorough discharge of the load, fast, dependable operation and sturdy construction insure lower operating and upkeep costs.

The new Western Drop Door Car has other advantages explained in Bulletin 27-QCM. May we send you a copy?

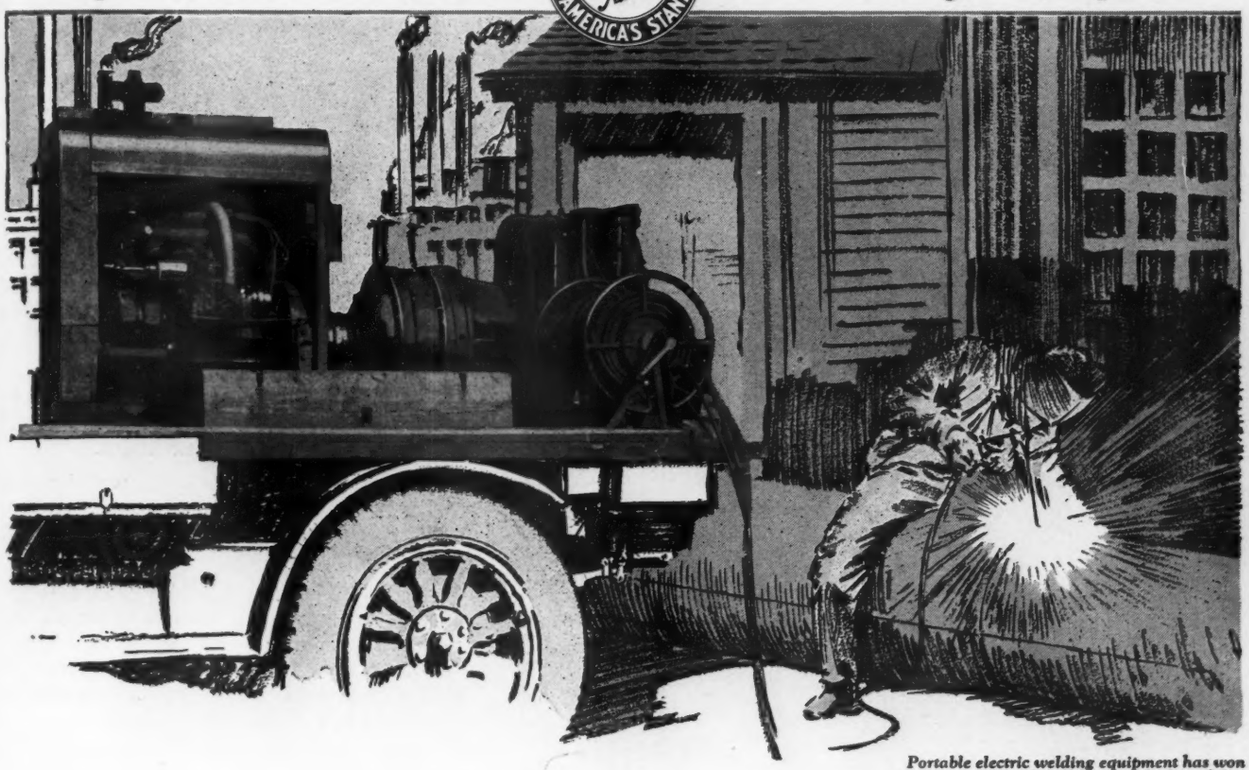
Western Wheeled Scraper Company
Aurora, Illinois

WESTERN

Pioneer Builders of Dump Cars

Dependable Power for Every Purpose

CONTINENTAL MOTORS · Power for the Nation · AMERICA'S STANDARD

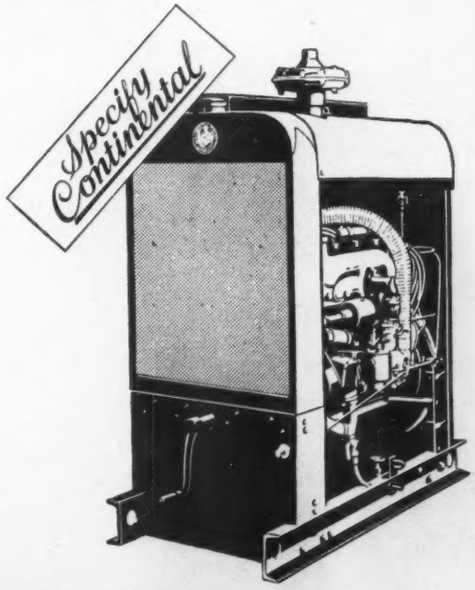


Portable electric welding equipment has won a new measure of confidence and adaptability since the efficient, dependable characteristics of Red Seal Continental motors have been combined in rugged, compact power units especially designed for this service.

The Peaks of Industry

Running along on peak production, day after day, calls for equipment which stands the strain without a falter.

Heavy duty Red Seal Continental motors furnish thousands of varying industries with a type of economical gasoline power which speeds up production and cuts manufacturing costs. In these varied fields Continental serves with a dependability which is the result of a specialized knowledge of power plant needs plus a quarter century's experience in developing such equipment for specific uses.



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INDUSTRIAL EQUIPMENT DIVISION
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The Largest Exclusive Motor Manufacturer in the World

Continental Motors

Compressed Air Magazine

NEW YORK LONDON PARIS

PRINCIPAL OFFICES
BOWLING GREEN BUILDING
11 BROADWAY
NEW YORK

VOL. XXXIII, NO. IV

APRIL, 1928

Getting Out Stone For A Great Cathedral

Vital Problem of Dependable Power Solved by Adopting Oil-Engine Drive

By R. G. SKERRETT

MORE power—dependable power—at low cost is the crying need of industry in many fields of effort. Low-priced power is the surest means whereby to give the skilled workman his dues. But worried managers will promptly ask: "How can we get this low-priced power and know that we can count upon a continuance of it after we once have got it?"

The purpose of the present article is to answer this very query which may be vexing a great many people at this time. And, as a striking instance of what can be accomplished, we are going to tell what has happened at a quarry, in New York State, engaged in getting out dimensional granite and cut stone for a truly splendid edifice that will represent, when completed, a total outlay of substantially $15,000,000.

Before detailing the way in which the quarrymen in question have solved their power problem, it may be well to review the situation of that part of the stone industry that is turning out stone for the building of monumental structures—monumental in size and character but not necessarily monumental in purpose. Stone for such structures is in steadily increasing demand, and for the best of reasons.

Because of its physical properties, its range of color, and its dignity of effect, stone has undeniable advantages in this field of use. Furthermore, stone of the right kind is enduring because nature has made it so through the cumulative action of ages: man but gives to this superior raw material his own expression of finish or superficial charm.

Despite these ample reasons for the utilization of cut or dimensional stone, the quarryman or the stonecutter often finds it difficult to meet specifications and to show a profit on his books when the work is done and paid for. This is especially true where a large volume of production is involved and the period of output is an unavoidably long one—covering a span of months or, possibly, of years.

2365

DIMENSIONAL stone for building and other structural purposes is produced annually in the United States in immense quantities. Stone is chosen for these uses because of its permanency, its color, and the way in which it lends itself to architectural art. Even so, stone has to contend with concrete and various other building materials. To hold its own in the face of rising production costs it is essential that the quarryman and the stonecutter utilize machinery wherever practicable and be able to command power at a relatively low and uniform price.

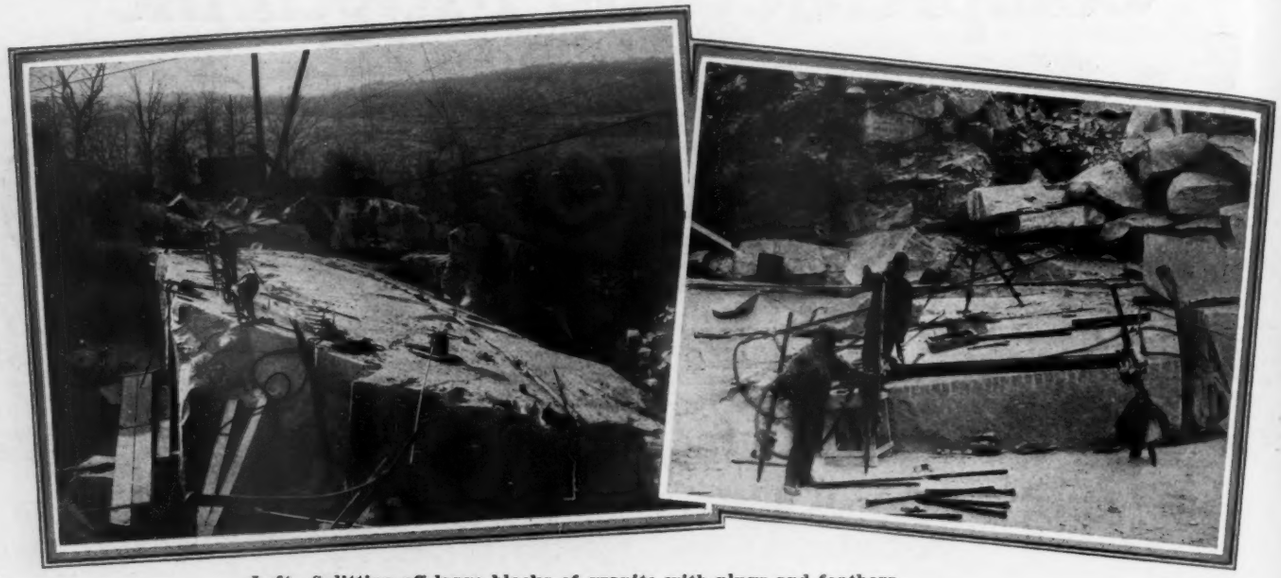
The accompanying article describes how one enterprising concern, engaged in quarrying and in finishing stone for a great edifice, has found it of economic advantage to install oil engines as a primary source of power for the various departments of the corporation's activities. Its experience may be of value to other persons or companies doing similar work.

During a considerable interval of this sort, various changes are likely to take place in operating costs; and many of these changes are of a kind over which the contracting quarryman or stonecutter can exercise but little if any control. He must, therefore, seek to minimize or to neutralize these vexatious variables by recourse to mechanical aids. But, to make these facilities a source of economic benefit, he must be able to keep his power costs for these machines as low as practicable and as nearly uniform as conditions will permit. To those that doubt that this can be done, we answer that it can be done; and we shall give convincing facts to prove it.

Near the crest of a hill to the north and east of Peekskill, N. Y., is situated the Mohegan Granite Quarry from which is obtained a beautiful, mellow granite in two shades—one light and the other dark. The light stone commends itself especially for trim, while the darker stone is admirably suited for main surfaces. An outcrop of this "golden granite" was discovered about 1895, but was not worked until 1900. Subsequently, Messrs. Grenci and Ellis joined hands in getting out stone from that source and in furnishing it for architectural and other purposes. This union of effort took place in 1917; and during that year they did their first work in connection with the Cathedral of St. John the Divine, in New York City—the contract having to do with granite now part of the base of the nave of that edifice. In 1925, Grenci and Ellis were incorporated.

Early in 1925, Grenci & Ellis, Inc., was awarded a contract calling for approximately 120,000 cubic feet of granite to be used in forming the exterior of the nave of the cathedral—the value of this stone being slightly in excess of $1,000,000. Actual production of this granite began late in the summer of that year; and since then the output has been maintained without interruption at a rate to meet the requirements of the setting operations.

A total of 30,000 cubic feet of granite was produced and delivered to the builders during 1926; and last year the output rose to 50,000 cubic feet. There now remains to be worked up for the completion of the nave a matter of 40,000 cubic feet. These bare figures and facts do not, in themselves, convey an adequate idea of what has been done by Grenci & Ellis, Inc., and what must still be done in order to keep pace with the erectors.



Left—Splitting off large blocks of granite with plugs and feathers.
Right—"Broach channeling" with an X-70 drill mounted on a quarry bar.

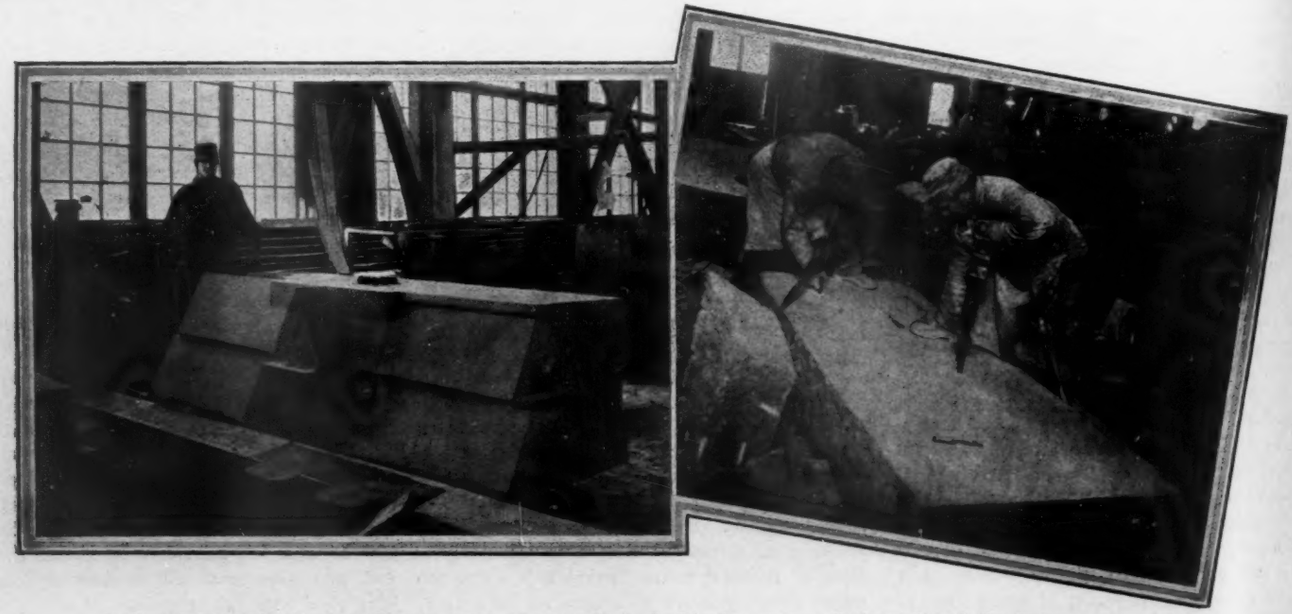
Perhaps the nature of the undertaking can be made somewhat clearer if we bear in mind that the character of the architectural design of the cathedral as well as the positions the finished stone will occupy greatly influence the rate of progress in producing the necessary stone. For example, as the walls of the structure rise higher and higher the task of fashioning the numerous pieces of granite becomes more intricate and exacting. This is due to the fact that the measure of ornamentation and the complexity of the design increase as the roof of the nave is approached. Every incidental and direct detail in turning out the finer work demands more thought and a greater expenditure of time.

In comparing the output of finished stone for 1926 with that produced in 1927, one should bear in mind that during 1926 the company was engaged well-nigh continuously in placing machinery throughout the cutting shed and in the quarry, while in 1927 this period of preparation was virtually brought to a close. Not only was more machinery added to the equipment of the plant but the cutting shed was much enlarged. In brief, the capacity of the cutting shed has been doubled twice in the last three years; and it is now 58 feet wide and 408 feet long. This expansion has been needed because Grenci & Ellis, Inc., is also busy providing stone for the imposing front of the cathedral.

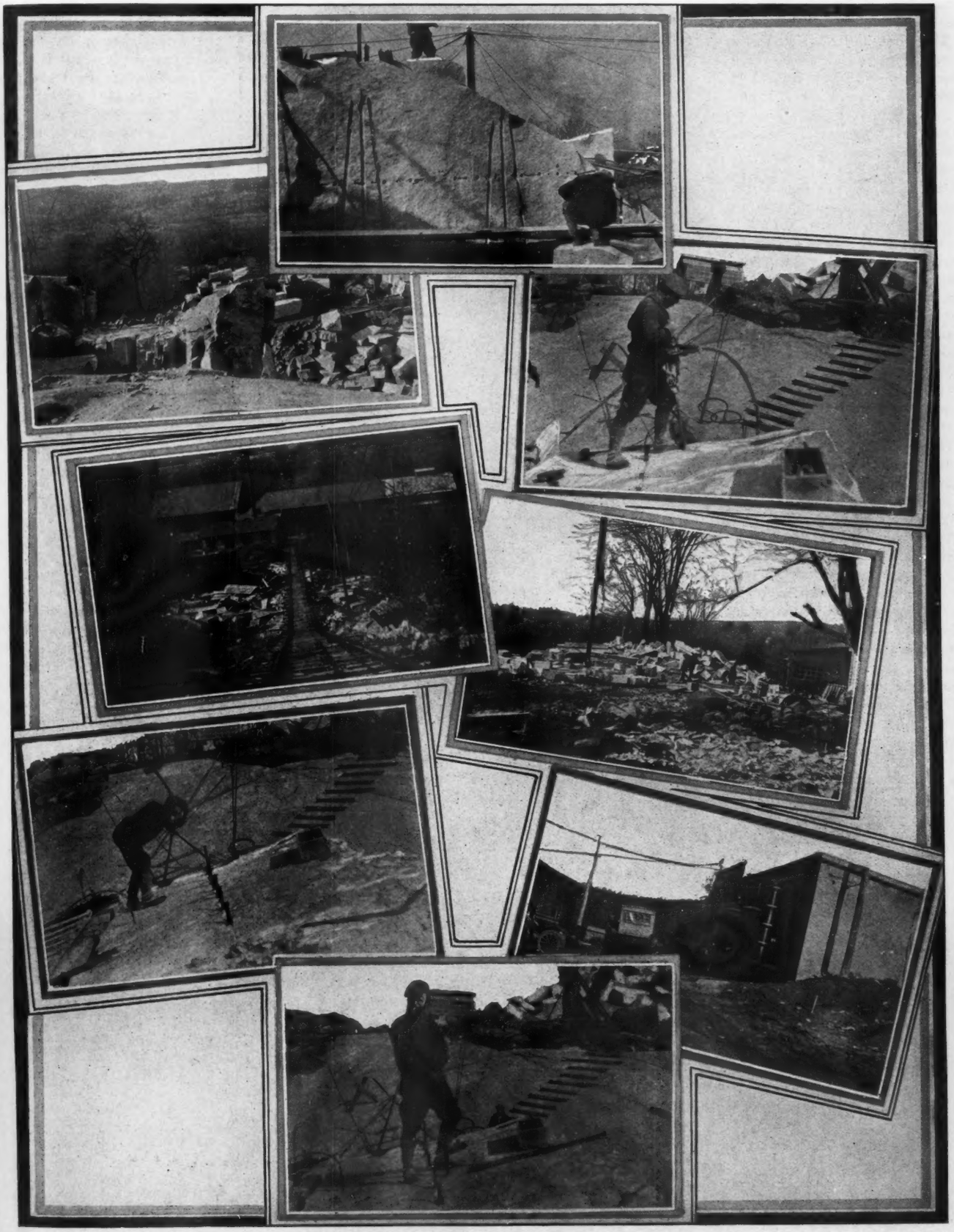
Prior to 1925, the power utilized at the Mohegan Quarry was furnished by a steam plant that was just about capable of meeting operating demands. The contract for the stone for the nave introduced new conditions that necessitated an increase in the working equipment at the quarry as well as amplified facilities for cutting and finishing stone in the shed.

The purpose of the additional mechanical equipment was twofold: to augment outp and, at the same time, to lower the unit co Such being the case, Grenci & Ellis, Inc., w confronted with the problem of choosing source of power that would be moderate i cost, dependable, and entirely within the co pany's own control. Therefore, after due i vestigation, the management decided in fav of oil engines as prime movers in supplyi compressed air and electric current for vario uses both in the quarry and in the cutting she

The first unit bought in pursuance of th program was a 110-hp. POC-2 compresso having a capacity of 600 cubic feet of free a per minute. This machine was erected in Ma of 1925; and during the month following a P oil engine of 110-hp. was installed for the pu pose of driving, by belt, an alternating-curre generator. This outfit answered only for little over half a year, when it became evide



Left—An example of what the stonecutter has to do in fashioning many of the units of the nave.
Right—Block-holing a piece of granite with air hammers preparatory to splitting it into several lengths.



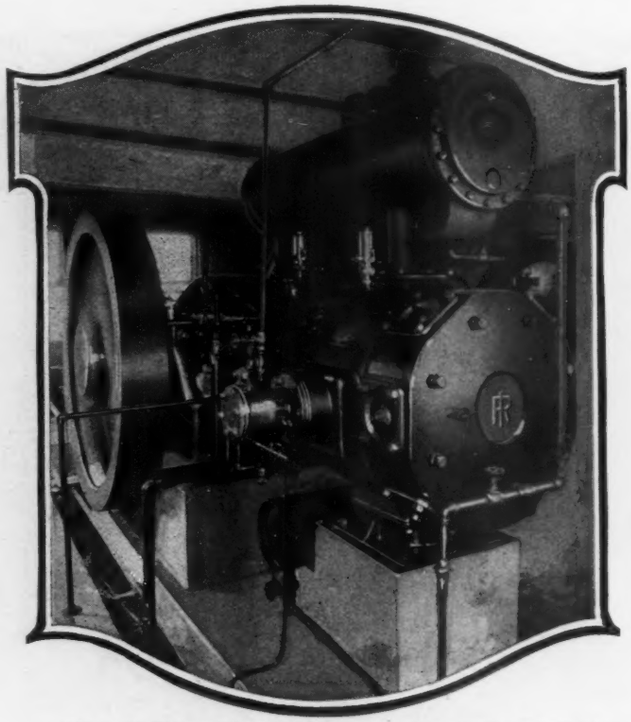
Snapshots here and there in the quarry and about the cutting shed from which comes the golden granite for the beautiful nave of the great Cathedral of St. John the Divine in New York City.

that more power was highly desirable both in the pneumatic and the electric services.

Therefore, in June of 1926, the company purchased a 600-cubic-foot air end for the 110-hp. PO oil engine, and thus converted it into a POC-2 compressor unit. Before doing this, however, Grenci & Ellis, Inc., in April of that year, secured a PR vertical oil engine of 250 hp.; and this engine was direct connected to an alternating-current generator rated at 175 kw. A 9-kw. belt exciter was also driven by this engine. This generator is the source of all current utilized by numerous motors performing various functions in the quarry and in the finishing shed. Perhaps it would help to a better understanding of the importance of this unit if we mention the principal equipment actuated by electricity.

There are two Parker rotary saws—one equipped with three motors having a total capacity of 89 hp., and the other with motors calling for a total of 39½ hp.; one Pollard carborundum edger, requiring 62 hp., and two Lane edgers having motors of 27 hp. each; two gang saws, one having a 30-hp. motor and the other a 40-hp. motor; three 10-ton cranes, each provided with a 20-hp. motor, and one 20 ton crane with a 40-hp. motor; a number of grindstones, for sharpening chisels, all of which are turned by a 10-hp. motor; two pumps that deliver water to the machines, each pump being driven by a 7-hp. motor; and three pneumatic surfacers, each of which has a suction fan operated by a 2-hp. motor.

In addition to the foregoing electrically driven equipment in or associated with the cutting shed, one of the five derricks in the quarry has electric drive. This derrick has an 80-hp. motor. There is also a 60-hp. motor which operates the hoist that is used in retrieving the cars that run upon the railway extending from the quarry down hill to the cutting shed. These cars carry the blocks of granite from the quarry to the shed. Since the adoption of the oil-engine units, steam has been employed only for heating the cutting shed in cold weather and for operating derricks.

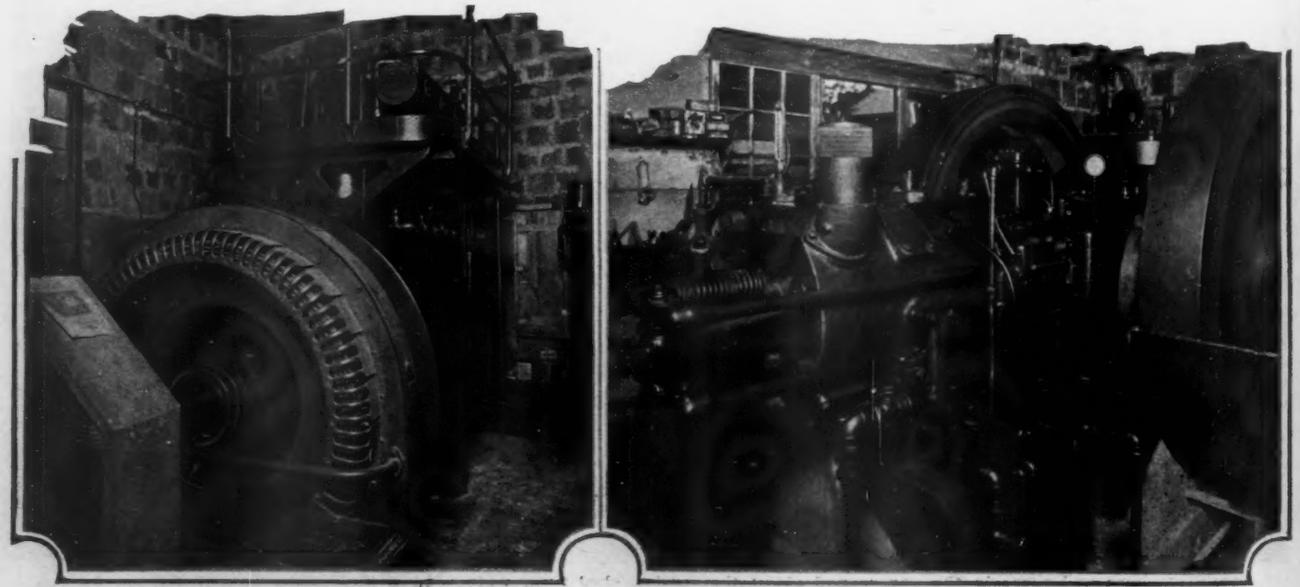


The two Ingersoll-Rand oil-engine compressor units are run almost continuously at full load during the working hours of each week day.

The oil-engine-driven generator and the stone-cutting machines in the shed are in service an average of ten hours a day and for six days a week. That is to say, the machines are on night duty for the purpose of getting out stone so as to provide an ample supply for the stonecutters during the day shift.

Both oil-engine compressor units are run simultaneously nine hours a day to insure sufficient air for the rock drills in the quarry and for the pneumatic surfacers and air tools utilized in the cutting shed. All told, there are 70 men engaged in stone-cutting in the shed, and each man uses air-driven tools.

In getting out rock in the quarry, the deep holes are drilled with an X-70 drifter, which is also employed for "broach channeling," and the rest of the drilling is done with "Jackhamers." Steels for the rock drills are kept fit for their work by a No. 50 "Leyner" sharpener. This air-operated machine is set up in a blacksmith shop at the quarry. The working force in the quarry, in the cutting shed, and in the power plant totals 150 men. Because of the mechanical aids provided, Grenci & Ellis, Inc., can now produce with a given number of men three times as much stone in the quarry and the finishing shed as was turned out ten years ago without those facilities. Not only that, but by using machines for the various operations they obtain 33⅓ per cent. more marketable stone from the raw material than would be possible if the work were done entirely by hand. An average of 5,000 cubic feet of finished stone is produced monthly.



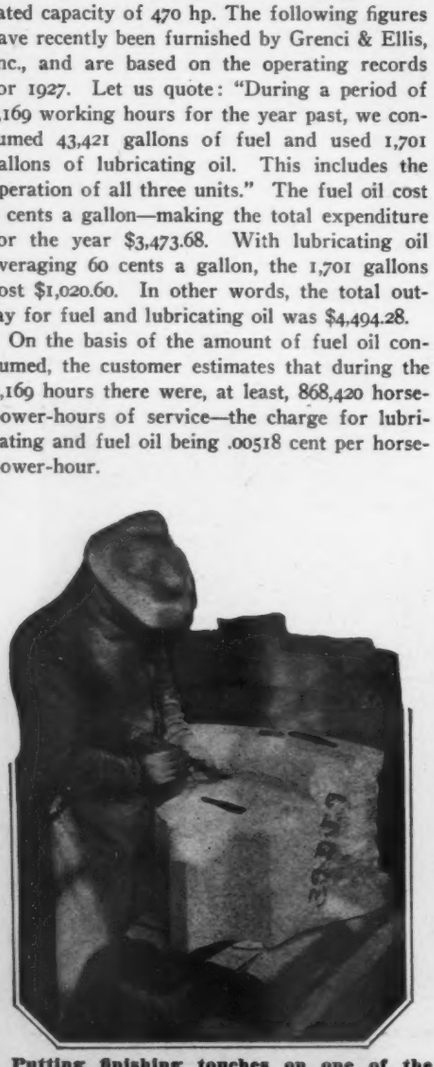
Left—The 250-hp. PR oil engine that drives the generator which furnishes electricity for many services at the Grenci & Ellis plant.
Right—One of the two 110-hp. POC-2 oil-engine compressor units which provide motive air for the quarry and for the cutting shed.

1—Edger, equipped with carborundum disks, cutting four slots simultaneously.
2—One of the two gang saws used in cutting blocks of granite into slabs.
3—Pneumatic surfacers quickly finish the faces of large blocks of granite.
4—This edger is equipped with a single carborundum disk for slotting pieces of granite so as to help the stonecutter in turning out finished work.
5—Putting new teeth on a universal rotary saw that cuts large blocks of granite.

Bruno M. Grenci.

The practical man will probably want to know just what savings have been effected by installing three oil-engine units having a total rated capacity of 470 hp. The following figures have recently been furnished by Grenci & Ellis, Inc., and are based on the operating records for 1927. Let us quote: "During a period of 3,169 working hours for the year past, we consumed 43,421 gallons of fuel and used 1,701 gallons of lubricating oil. This includes the operation of all three units." The fuel oil cost 8 cents a gallon—making the total expenditure for the year $3,473.68. With lubricating oil averaging 60 cents a gallon, the 1,701 gallons cost $1,020.60. In other words, the total outlay for fuel and lubricating oil was $4,494.28.

On the basis of the amount of fuel oil consumed, the customer estimates that during the 3,169 hours there were, at least, 868,420 horsepower-hours of service—the charge for lubricating and fuel oil being .00518 cent per horsepower-hour.



Putting finishing touches on one of the many pieces of golden granite for the nave of the Cathedral of St. John the Divine.

The significance of the foregoing economies is intensified by the dependability of the service given by the three oil-engine units. To be specific, the oil-engine generator set operated for a period of two years without a single shutdown; and in the course of those 24 months the POC-2 units were out of service a total of only two hours—this time being required to make certain bearing adjustments. No wonder Mr. Grenci has recently said: "The oil engines have performed extremely well."

COMPRESSED AIR CHECKS FOREBAY ANCHOR ICE

THE formation of anchor ice in the Oswego River at the dam of a manufacturer thereon has been of such a serious nature at various times, according to the *Electric World*, as to necessitate a shutdown of the plant for a considerable period. In an endeavor to correct and to prevent this condition, the corporation, which now controls the water-power rights in this river and supplies power to the manufacturer, has recently installed an unusual system for the disposal of anchor ice by means of compressed air.

The two dams belonging to the company have been equipped with this device; and its satisfactory qualities in maintaining service at the intake have been demonstrated. The essential feature of the apparatus consists of heavy brass pipes, imbedded in concrete near the bottom of the forebay, through which compressed air may be released at intervals. One set of 4-inch extra-heavy brass pipes is located directly behind the trash rack, and extends across the whole frontage of the refuse interceptors. Another series of pipes is located about 35 feet upstream and 1 foot above the floor of the forebay, and likewise extends across the entire distance. Compressed air under 100 to 155 pounds pressure is released by means of a specially designed pop valve; and the first rush of air contributes largely to the satisfactory displacement of trash and to the breaking up of the ice. The 3/16-inch holes in the pipes are on 1½-inch centers to allow the escape of air in several directions.

Material raised from the bottom by the use of this equipment as well as ice floating on the surface of the water in the forebay are permitted to discharge through a secondary spillway located at the side of the dam and extending about 6 feet below mean water level. Heavier material, which has been dislodged from subsurface positions, remains partway afloat in the turbulent water and passes over this discharge passage. In operation, air is forced through the pipes at such intervals as may be necessary, depending on the temperature and the accumulation of refuse.

Because of the efficiency of this device in remedying the conditions for which it has been designed, it is not necessary to have such a fine mesh or spacing for the bars of the trash rack. This enables a less expensive type of rack to be used, and does not restrict the flow of water in the event the rods or bars become corroded.

Our readers will probably recall that the utilization of compressed air to prevent the formation of ice against the spillway gates of the great Keokuk Dam, on the Mississippi River, was dealt with at some length in the January, 1923, issue of *Compressed Air Magazine*. That installation proved conclusively the correctness of the system.

PURIFIER FOR STEAM, GAS, OR COMPRESSED AIR

THE same principles that have made the "tracyfier," manufactured by the Andrews-Bradshaw Company, a commercial success in purifying steam, gas, or compressed air have been embodied by that company in a smaller, pipe-line tracyfier that has been developed for use in connection with steam, gas, or air lines up to 3 inches in size.

When placed in a saturated-steam line, this type of tracyfier is said to remove all moisture from the steam—thus making it possible to deliver standard-specification steam free from solids, both soluble and insoluble. Samples of

A partly assembled 1½-inch pipe-line "tracyfier" designed to remove moisture from steam and air lines.

condensed steam so purified have shown no more than 9 parts total solids in 1,000,000 parts.

Obviously there are many fields of application for such a purifier. When attached to a steam line leading to a gas producer, the device—so the makers report—will maintain a more uniform hydrogen content in the gas. Again, in the case of a steam line feeding a tar burner on an open-hearth furnace, the tracyfier tends to produce a shorter, hotter, and more uniform flame; effects a saving of about one gallon of tar per ton of steel; and keeps the checker chambers cleaner than would otherwise be possible. In laundry and paper driers, the amount of work handled by the driers is increased if there are tracyfiers in the steam lines. These are but a few of the many uses to which the purifier can be put.

Clean air, so essential to the operation of pneumatic tools, can be obtained by placing the tracyfier in the air line close to the air-driven tools; and one tracyfier will dry and clean the air for several tools. It is claimed that its employment will not only cut down the out-of-service time but will also augment the output of the tools.

Stanford University's Enlarged Stadium

Wooden Structure Given Appearance of Monolithic Concrete By Means of the Cement Gun

By C. T. KEEFER

WHEN 80,000 enthusiasts roar their approval the air is vibrant with a great volume of sound. To the person on the outside, this, in itself, is one manner of sensing the magnitude of the Stanford Stadium when a track meet or a football game is in progress.

Stanford University, California, like all our large educational institutions, has done much to foster athletics; and to this end it has successively developed its stadium so that the structure, originally built to seat 60,000 people, can now accommodate as many as 87,000.

Air for operating the cement guns, used in guniting the exterior of the stadium, was furnished by portable compressors.

The stadium in its present form is of special interest because of the rather novel design of the structure. Besides its great seating capacity, it has a football field and a ¼-mile running track combined with a 220-yard straightaway.

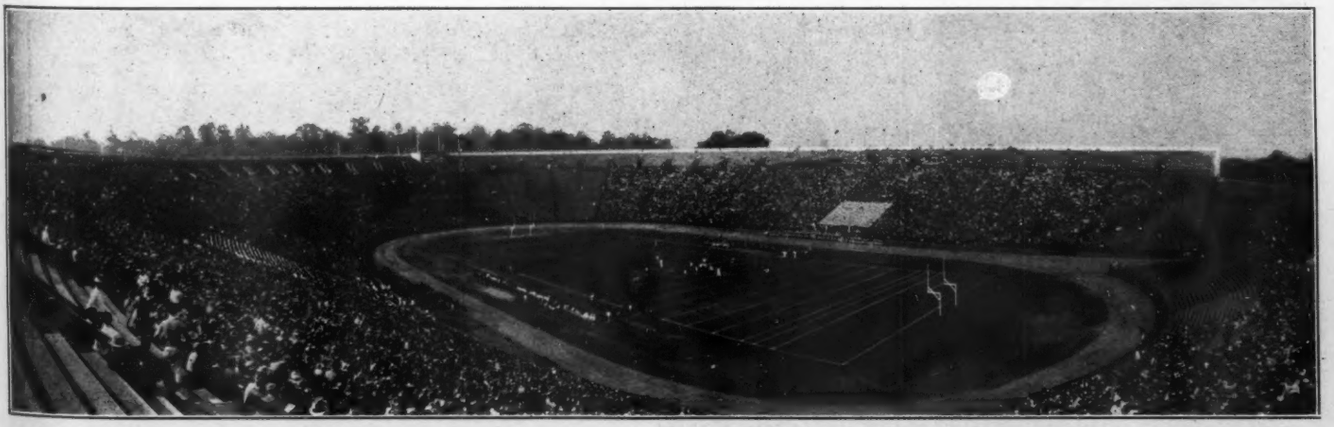
Originally, the stadium was formed by excavating and depressing the playing field about 20 feet below the ground level. The earth so obtained was banked around the enclosure; and on the inner slope wooden seats were erected. The top of the embankment is about 40 feet above the ground level; and the stadium is entered by ascending steps located at intervals around the exterior of the structure. As first built, the stadium had the shape of a horseshoe, with one side of the horseshoe somewhat longer than the other so as to provide for the straightaway in conjunction with the running track.

Subsequently, in order to increase the seating capacity, the open end was partly closed with an earth-fill embankment on which were placed 10,000 additional seats—thus raising the total to 70,000. The earth for this embankment was obtained from material excavated in constructing a depressed ball field in the vicinity.

Owing to the great demand for seats, especially at the time of the annual Stanford versus University of California football game, it was again apparent that it would be necessary further to augment the seating capacity; and the economical solution of the problem lay in erecting a superstructure on top of the earthen embankment so as to provide for 17,000 more people. This arrangement has brought the total number of seats up to 87,000.

From an architectural standpoint it was desirable that the superstructure should be of the monolithic-concrete arch type. However, for reasons of cost, timber construction was decided upon. But, to meet architectural requirements, the exterior of the stadium was to be so finished as to give it the appearance of a concrete structure. Several ways of doing this were considered; and, after due deliberation, the cement gun was chosen as the most practicable means of applying a coating of concrete to the expansive outer surface of the great stadium. Not only was every demand thus satisfied but added strength and rigidity were imparted to the structure.

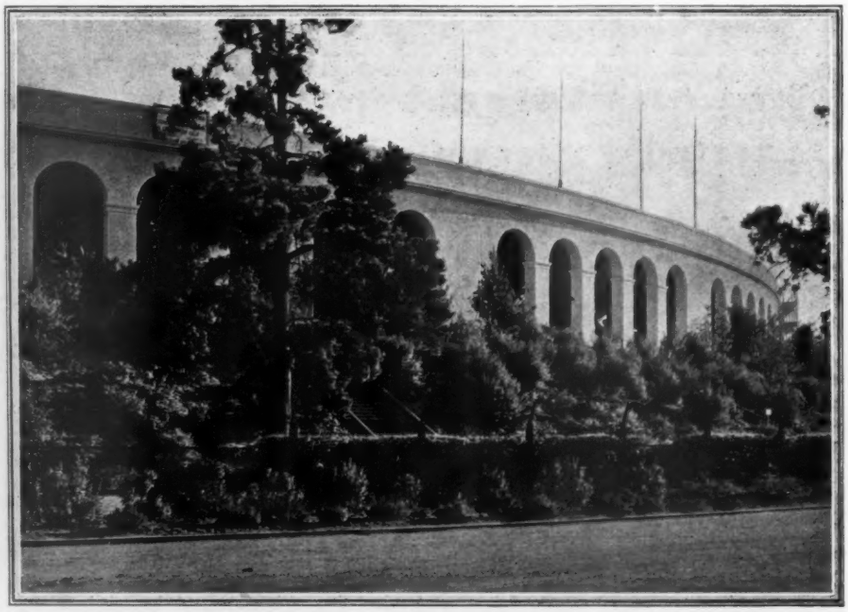
The gunite used consisted of a mix of cement and sand in the proportions of 1 part of cement to 4½ parts of sand. These materials are introduced into the cement gun in a dry state and then blown by compressed air through a delivery hose to the mixing nozzle. At that point water is admitted; and the resulting mortar is shot on to the surface to be covered. Such a mix will test about 4,000 pounds when subjected to compression; and is considerably stronger than the usual run of concrete. The great strength is probably due



The stadium during a football game. All told, 87,000 people can be seated.

to the low water content of the mass and to the fact that the mortar is blown into place at high velocity, tending to compact the material and to make it dense. This density also makes gunite highly impervious to water.

The slab or coating of gunite, as applied to the exterior of the wooden framework, is ⅞ inch thick, and is reinforced with 2x3-inch diamond-mesh expanded metal weighing 3.6 pounds per square yard. The material was shot directly on to the 2x6-inch framework studs spaced on 16-inch centers. No wood sheathing was used. This was not deemed necessary because of the additional strength given to the structure by the ⅞-inch coat of reinforced gunite.



A pleasing architectural effect was obtained by guniting the enveloping structure of the Stanford Stadium.

The backing against which the gunite was blown consisted of 18-gage wire and heavy 15-pound building felt. The wire was first stretched, 1 foot apart, over the studding, and then the felt was nailed to the studs with large-head tacks. The purpose of the wire was to stiffen the felt so that it would stand up under the impact of the gunite. On top of this the reinforcing mesh was placed, furred out, and nailed securely to the studding at 8-inch intervals.

All told, 11,000 square yards were thus gunited; and in this work three cement guns were utilized. The necessary operating air for these guns was furnished by a corresponding number of portable compressors of Ingersoll-Rand make. The total cost of the Stanford Stadium as it is today, exclusive of the value of the land, is $570,000. This is rather low, considering its size and the return on the investment. The method by which the structure has been developed to its present form has been an economical one, because the investments involved have kept pace with the demand for seats. In other words, interest charges on excess seating capacity have been obviated.

The engineering firm of Baker & Ormsby has had charge of the design and the construction of the stadium, and Palmer & McBryde executed the contract. The cement-gun work was done by the Cement Gun Construction Company of California, as subcontractors.

FARADAY'S SARCASTIC JEST COMES TRUE

UNDER this heading the *Southern Power Journal* recently published the following instructive item:

In 1831, after seven long, hard years of labor with one object in view, Michael Faraday succeeded in producing an electric current by induction. One day, in his laboratory, he explained the experiment to a friend—one of those matter-of-fact sort of chaps—who said: "Very interesting, but what is the use of it?" To which Faraday somewhat sarcastically replied: "Perhaps some day you can tax it."

When it is considered that the great electrical industry of the present is based primarily upon Faraday's epochal discovery, the truth of his jesting remark may be understood. Today the electrical industry is the third largest taxpayer of corporation taxes in America, and will doubtless soon stand at the head of the list. In 1926 the electrical industry of the United States paid $163,000,000 in taxes.

MATCHING COLOR BY THE AID OF RADIO

IN the March issue of *Compressed Air Magazine* we described how paper in the making is being weighed in a New England plant by the aid of tuned radio. Now the Institute of Technology reports that colors can be matched by means of the same electrical impulses.

The color specimen is placed in a holder close to a high-powered electric lamp. Light is alternately reflected from this specimen and from a block of magnesium carbonate, the whitest-known substance—the variations in the reflections from these two surfaces being registered by a photoelectric cell and transmitted in electrical impulses by either wire or radio.

The device was developed at the institute and makes it possible exactly to reproduce or to match any shade of any color—in short, removes all chances of visual error.

The per capita consumption of coffee in the United States in 1927 amounted to 12 pounds.

Left—The finished stadium viewed from without.
Right—The interior of a section of the stadium giving an idea of its immense seating capacity.

Guernsey Dam Helps Irrigate Lands In North Platte Valley

This New Structure in Wyoming Supplements the Pathfinder Storage Basin by 72,000 Acre-Feet

By C. H. VIVIAN

THE United States Bureau of Reclamation is concerned with the endeavor of making two blades of grass grow where but one grew before, or, more often, where none grew before. It plans, constructs, and administers suitable engineering works to store river water and to distribute it to arid and semi-arid lands, thereby making it possible for those barren areas to yield crops and to support habitation.

The bureau functions as a division of the Department of the Interior. It is directed by a commissioner, Mr. Elwood Mead. Activities are confined to seventeen states in the West; and all matters relating to the management and the performance of work in the field are directed from Denver, where Mr. R. F. Walter is in charge as chief engineer.

The program is carried out under the provisions of the Reclamation Act passed by Congress June 17, 1902. Since that time the bureau has built more than 100 storage and diversion dams, giving rise to reservoirs that have a total storage capacity of 10,500,000 acre-feet of water—a sufficient volume to inundate the entire State of Massachusetts to a depth of nearly 29 inches. The work also has included some 16,000 miles of canals, ditches, and drains—involving the excavating of a yardage greater than that removed in digging the Panama Canal. Likewise, it has called for the erecting of 145,000 canal structures, and the building of 11,000 bridges, 12,500 culverts, and 106 tunnels of 29 miles aggregate length. More than 700 miles of concrete, metal, tile, and wood pipe has been laid; and 4,500 concrete, metal, and wood flumes, 150-odd miles long, have been installed. In all, 33 projects have been constructed or are now under construction.

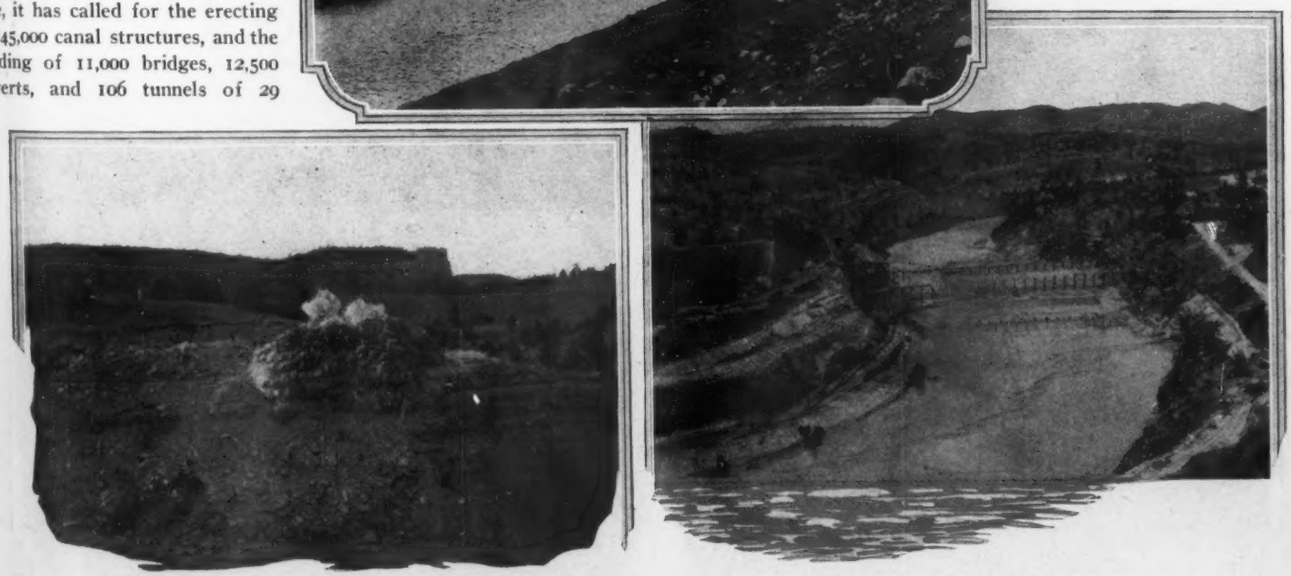
In connection with these projects, the bureau has erected 1,600 buildings—including power plants, pumping stations, offices, residences, barns, and storehouses—and has run 1,075 miles of roads, 83 miles of railroads, 3,350 miles of telephone lines, and 1,675 miles of transmission lines. More than 81,668 hp. is developed by the associate water and steam power plants.

In 1926, there were 24 projects in operation, and the land under irrigation aggregated 1,409,932 acres. Of this area, 1,311,405 acres were cropped—their yield having a value of $60,331,245, or an average of $46 to the acre. This is striking when compared with a value of $19.07 per acre production for the ten principal crops in the United States as a whole. The acreage remaining was set out with young fruit trees and planted with alfalfa.

Figures compiled in 1925 show that 136,872 persons were living on the 37,530 farms then within the irrigated zones, while there was an additional population of 365,742 in the 203 cities and towns in the same zones. These communities were served by 645 churches and 656 schools, as well as by 146 banks with total deposits of $125,222,000.

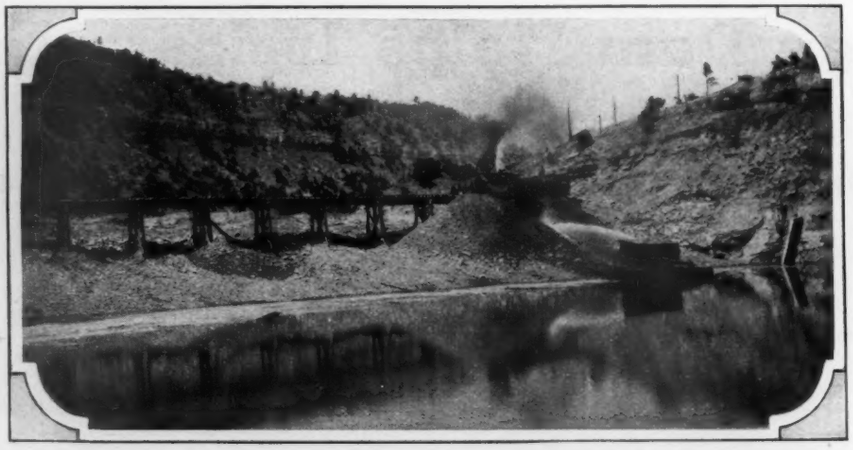
One of the recently completed undertakings of the bureau is the Guernsey Dam, on the North Platte River, in Wyoming. It is a unit in the North Platte Project, which will ultimately reclaim 237,000 acres of land in southeastern Wyoming and western Nebraska. This scheme was started in 1910 with the construction of the Pathfinder Dam at a point three miles below the junction of the North Platte and Sweetwater rivers, about 50 miles southwest of Casper. This structure is notable because it is one of the highest rock-masonry dams in the world. It rises 218 feet above its foundation.

The North Platte River has its



Top—The dam as it appeared from the upstream side when nearing completion. The river is seen flowing into the diversion tunnel, through which it was by-passed during the construction of the dam.
Left—Blasting the channel for the north spillway.
Right—The dam, seen from the downstream side, at an early stage in its construction.

source in that section of northern Colorado known as North Park. It is a region of high mountains and heavy winter snowfall. The melting of the snow in the spring and early summer produces a great volume of run-off water that is caught and stored behind the Pathfinder Dam until it is needed in the river valley below. The storage capacity at Pathfinder is 1,070,000 acre-feet.



The materials for the dam were dumped from trestles and sluiced to the center of the structure in the manner shown.

The lands irrigated comprise a belt extending along either side of the North Platte for 100 miles and having a maximum width of 25 miles. This irrigable area is 175 miles from the Pathfinder Dam as the river runs. The water is released from the reservoir as required, and flows thence down stream. At Fort Laramie, Wyo., it is diverted by the Whalen Dam into canals, on either side of the river, which distribute it through 1,329 miles of suitable laterals and branches to the points of use. The Fort Laramie Canal, on the south side, has an initial carrying capacity of 1,440 second-feet of water, while the capacity of the Interstate Canal, on the north side, is 2,200 second-feet.

The Guernsey Dam is expected to improve the functioning of the system. It is situated ten miles above the Whalen Diversion Dam and, hence, 165 miles below the Pathfinder Dam. Its purpose is threefold: to supply a supplemental storage basin for the conservation of the inflow to the North Platte below the Pathfinder Dam; to provide closer river control of the water released from the Pathfinder Reservoir; and to develop electric power.

There is a human interest story in connection with the Guernsey Dam. The structure takes its name from the town of Guernsey, one mile down the river, which was founded by C. A. Guernsey, a pioneer in that section and still a resident there. Mr. Guernsey recognized, when he first explored the region, that the narrow cañon now blocked by the Guernsey Dam was the strategic point for such a structure. About that time the State of Wyoming created the office of state engineer. Mr. Guernsey promptly applied for a dam-site permit, and was granted Permit No. 1 by the new office. During subsequent years he endeavored without success to interest private capital in a development plan which he saw was feasible. When the Bureau of Reclamation was created he transferred his efforts towards securing Federal authorization of the scheme; and he has lived to see his visions come true. It so happens that the first state engineer of Wyoming who granted the Guernsey permit was Elwood Mead, the same Mr. Mead who, as commissioner of the Bureau of Reclamation, has supervision over the consummation of the North Platte Project, of which the Guernsey Dam is an integral part.

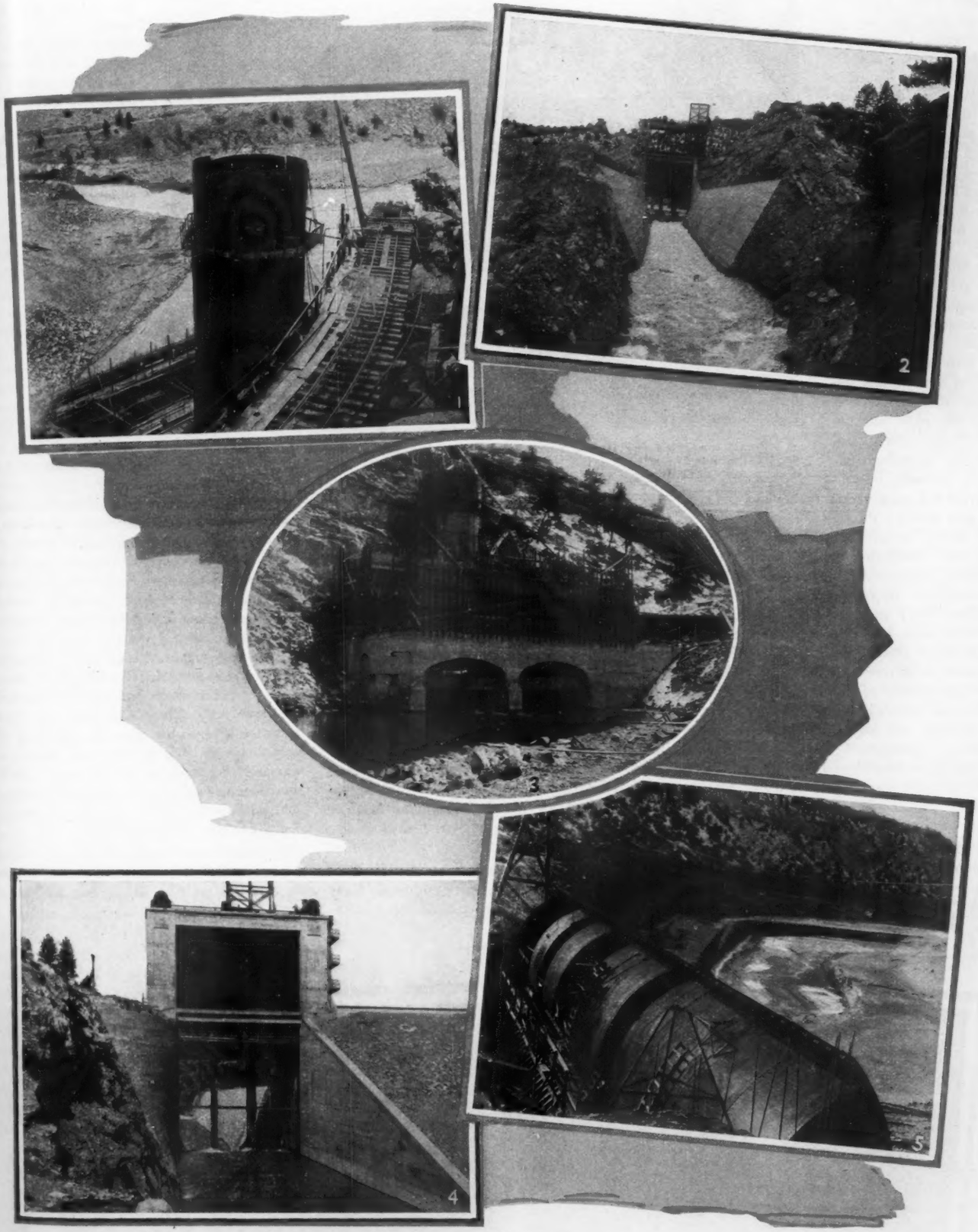
The Guernsey Dam is a composite structure of rock, sluiced gravel, and clay. It has a puddled core extending from 30 feet below the original river bed upward to the crest. The crest is 105 feet above the river bottom, is 26 feet wide, and has a length of 560 feet. The thickness of the dam at the base is 1,000 feet. The total cost of the dam, power house, and accessory structures was about $2,450,000. The dam, itself, was built at an expenditure of $1,700,351, as against an estimated cost of $1,780,000.

The contract was awarded May 4, 1925, to the Utah Construction Company of Salt Lake City. Work was begun on June 1 of that year and, except for the installation of one generating unit in the power house, was completed in July, 1927. A portion of the work was sublet to Morris & Knudsen of Boise, Idaho. Mr. F. T. Crowe, formerly of the Denver office of the Bureau of Reclamation, was superintendent in charge of the contractors' operations; and F. F. Smith served as resident engineer on the project for the Government.

The upstream side of the dam has a slope of 3 to 1, and is faced with rip-rap of 3-foot size. The downstream face has an initial slope from the crest of 2 to 1. This changes farther down to 8 to 1, and, at the toe, to 3 to 1. The base of the core was placed in a trench 30 feet deep and extending across the river bed. In excavating this trench, the materials were handled by means of a slack-line cableway using Page buckets especially adapted by Superintendent Crowe to fit the needs. The buckets were dumped directly into 4-cubic-yard cars.

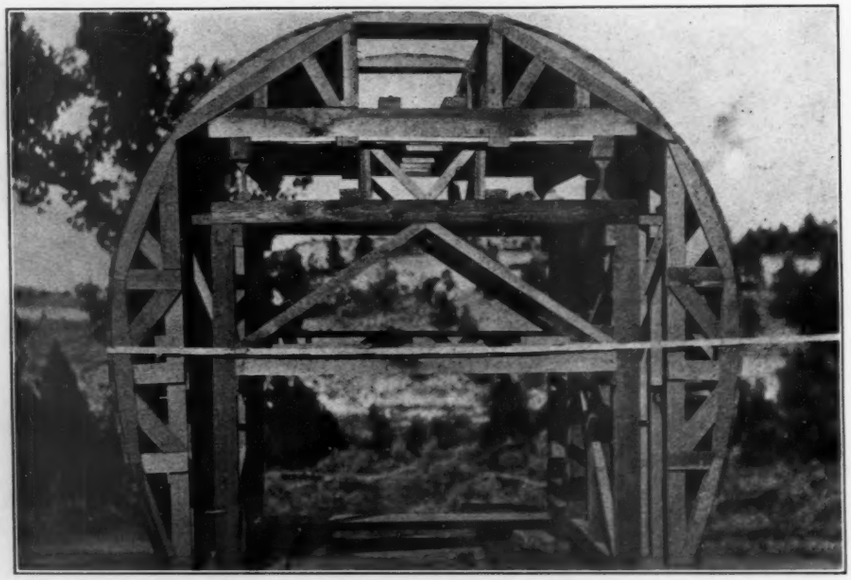
The total quantity of materials required for the dam was 510,000 cubic yards, made up of

Looking down the North Platte River upon the Guernsey Dam site soon after construction work had started.



1—Surge tank and power house in course of construction.
2—Looking up the north spillway channel toward the discharge gate.
3—Close-up of the power house with the surge tank in the background.
4—The 50x50-foot Stoney gate in raised position. An idea of the size of the structure may be obtained by comparing it with the human figures on top of it.
5—The two drum-type gates at the south spillway viewed from the downstream side.

365,000 cubic yards of gravel and clay and approximately 145,000 cubic yards of rock. The fine materials were loaded into Western dump cars and dumped at convenient points from trestles, which were progressively raised as the dam attained height. They were then sluiced to the center area to form the relatively impervious core. One Shay geared engine and seven rod-type 18-ton engines were used in the haulage of the materials. The sand and clay were obtained largely from borrow pits upstream from the dam site, while the rock was secured from tunnels and spillways excavated under the contract.



Small model of the jumbo form used in placing the concrete lining in the 30-foot diversion tunnel.

During the construction of the dam, the river flow was diverted through a tunnel, 1,168 feet long, driven in the south wall of the cañon. Upon the completion of the spillways, the temporary entrance to this tunnel was closed with concrete. As excavated, the bore was of horseshoe shape and 33 feet in diameter. It was lined with 18 inches of concrete placed pneumatically around jumbo forms of wood. The tunnel is in limestone and sandstone, with an occasional band of low-grade hematite; and the material removed totaled 36,000 cubic yards. The drilling was done with Ingersoll-Rand DCRW-23 "Jackhamers" mounted on columns. The heading-and-bench method was followed. An air-operated shovel was used for loading the muck into cars, which were hauled by gasoline locomotives.

Immediately over the intake end of the diversion tunnel and connected with it by means of a concrete-lined shaft, 31 feet in diameter, is a spillway. The flow is controlled by two drum-type gates, each 14½ feet high and 64 feet long, set in concrete. The pressure of the reservoir water against these gates automatically regulates the outflow. When the reservoir is full, the discharge capacity is 30,000 second-feet.

Water for power generation enters the diversion tunnel through an intake, at the shore line, a short distance upstream from the spillway. The power tunnel opens off of the diversion tunnel and parallels it at a distance of 42 feet between center lines. This bore is of circular section, has a diameter of 12 feet, and is 610 feet long. It is lined with 15 inches of concrete which was shot in place with compressed air. The drilling work entailed in driving the power tunnel was done with column-mounted "Jackhamers" of the same type used in the larger tunnel.

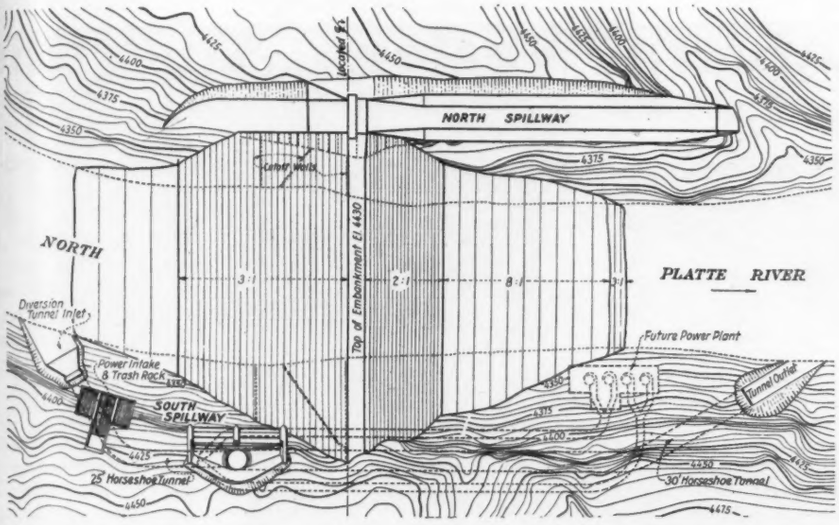
The principal spillway and outlet for the irrigating water is at the north end of the dam. It is a concrete-lined open cut, 25 feet wide at the bottom, with steeply sloping sides. Approximately 96,000 cubic yards of rock was excavated to form this spillway. DCR-23 "Jackhamers" were employed in its removal; and down-hole drilling was practiced. Despite the fact that the rock conditions were not entirely favorable, there was very little overbreak of material. All the drill steels were heated in a No. 25 oil furnace and were conditioned by a "Leyner" No. 50 sharpener. The blasting of the north spillway cut required 72,000 pounds of explosives, or an average of three-fourths of a pound for each cubic yard of material broken out.

The discharge into this spillway is controlled by a 50x50-foot Stoney gate, which is the largest of its type in the United States. The leaf of this gate weighs 217 tons, and consists of steel face plates riveted to steel ribs. It is raised and lowered by an electric motor—the operations being aided by counterweights of 180 tons.

An ample supply of sand and gravel suitable for concrete was found adjacent to the dam site at a point which had once been a part of the river bed. These materials were handled from the bank to the concrete plant by a cableway conveyor. A 1-cubic-yard Smith mixer was used for making the concrete. Much of the concrete was placed during the winter season, with temperatures ranging as low as 22 degrees below zero Fahrenheit.

From the power tunnel the water passes into a surge tank 85 feet high and 22 feet in diameter. It was built up of sections of steel plate 8 feet wide; and an ingenious method was

**Left—Drilling a heading in the diversion tunnel with DCRW-23 "Jackhamers."
Right—Section of the 30-foot diversion tunnel with the concrete lining in place.**



General plan of the Guernsey Dam and associate power development. Two power tunnels are shown, but only one of them is now in use delivering water to generating units.

employed to facilitate its construction. After the first course was in position, the inside of the tank was filled to a suitable level with water, on which was floated a circular raft of a size that just fitted into the available space. This formed a solid floor for the workmen and materials, and eliminated the need of tackle and scaffolding inside the structure. As each new section was added, the water level was increased by 8 feet, thereby raising the platform to the proper height for the placing of the next section. The tank plates were riveted with Ingersoll-Rand 6-A riveters.

Two penstocks, each 8½ feet in diameter, carry the water to the generating units. Each of these units consists of a 3,400-hp. vertical hydraulic turbine connected to a 3,000 kv-a. generator with a direct-connected exciter. Current is generated at 2,300 volts and 60 cycles. The income from the sale of power promises to amortize the investment in the course of a comparatively few years.

Farther down the river, at Lingle, Wyo., is a 1,750 kv-a. power house with which the Guernsey plant has been interconnected. The power from these two stations is being used in various ways. A considerable amount of it is consumed by the Colorado Fuel & Iron Company in its iron-mining operations at Sunrise, Wyo., six miles from the Guernsey Dam. All towns in the North Platte Project are supplied with current from these sources. The Mountain States Power Company has recently contracted for a block of power, and is constructing an 85-mile transmission line to tie in with its system that serves Casper, Wyo., and neighboring points.

When full, the Guernsey reservoir will cover an area of 2,336 acres. The storage capacity is 72,000 acre-feet. Water will be backed up the river valley for a distance of 13 miles, forming a lake of scenic beauty. The irrigable lands to which the water is diverted are in Goshen County, Wyoming, and in Scotts Bluff and Morrill counties, Nebraska. They occupy an area lying at an altitude of from 3,800 to 4,500 feet; and the prevailing climate makes the region a desirable place of residence. The land is fertile; but recourse to irrigation is essential to the growth of crops because the mean annual rainfall is only 14.74 inches. The irrigating season extends from April 1 to September 1; and the principal crops, in the order of the acreage devoted to them, are: alfalfa, sugar beets, potatoes, oats, corn, wheat, and barley.

There are four sugar-beet factories in the district. The beet tops, beet pulp, and other by-products of this industry, as well as the alfalfa grown on the farms, are utilized in stock feeding. As many as 200,000 sheep and 30,000 cattle have been provided for in the valley in a season. Dairying and poultry-raising also are extensively carried on. The section, with its population of approximately 40,000 persons, is served by two railroads and traversed by the Lincoln Highway.

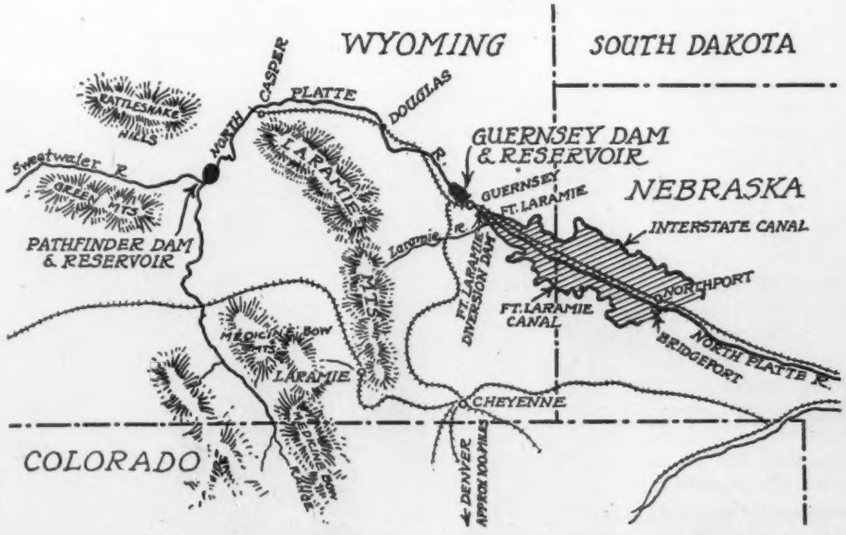
HIGH-PRESSURE GAS LABORATORIES

THE Imperial College of Science and Technology, of London, is adding two new laboratories to its facilities that are designed especially to promote study and research in the field of high-pressure gas. One of these laboratories will contain high-pressure explosion bombs and two pressure catalytic-tube units, and the other is being provided with apparatus for preparing, storing, and compressing gases, for determining the compressibility of gases, for calibrating standard gages, etc., etc. Outside the building housing these laboratories there is being erected an experimental gas-generating plant and several gas holders, the largest of which will have a capacity of 3,000 cubic feet.

When complete, according to *The Engineer*, the equipment will include two gas compressors: one working up to a pressure of 200 atmospheres and the other up to 1,000 atmospheres; a wide range of explosion bombs capable of withstanding explosive pressures ranging from 100 to 20,000 atmospheres; and catalytic-tube units that can withstand pressures up to 500 atmospheres at 932°F.

The United States exports of industrial machinery in 1927 reached a value of $180,000,000 and exceeded the shipments for any year since the abnormal postwar record of 1921. Compared with the 1926 total of $156,618,000, this trade represents an increase of 15 per cent. Perhaps the most consistent gain in the miscellaneous machinery group was made by the air compressor which, in 1927, accounted for an aggregate export value of $5,873,000 as against $4,665,000 in 1926.

A power plant designed to burn lignite is to be built by American capital at Estevan, Sask. The estimated cost of the project is $5,000,000; and current is to be supplied throughout an area of 10,000 square miles in southern Saskatchewan.

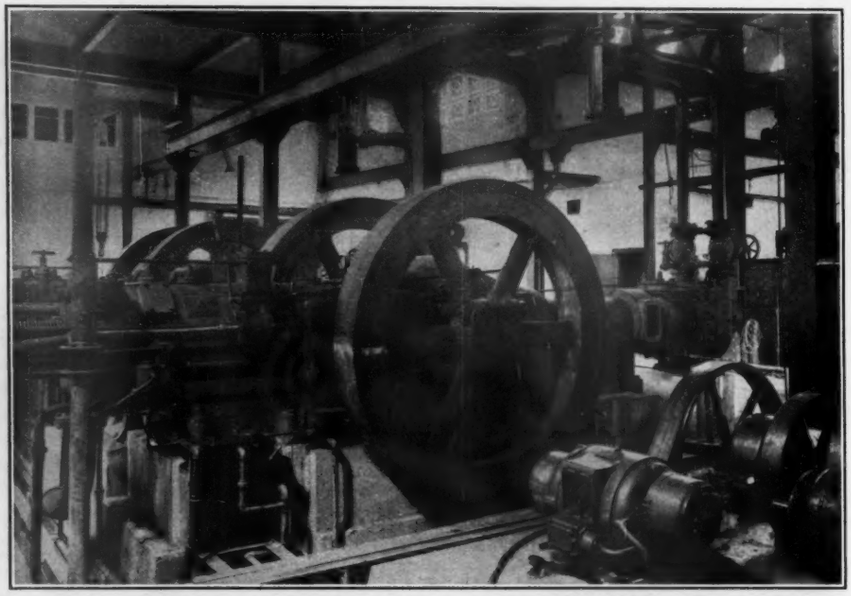


Sketch showing the relationship of the Pathfinder and the Guernsey dams to the North Platte irrigation district.

Modern Ice Plant In Western Australia

By R. C. WALLACE

MANUFACTURED ice is yearly gaining favor in the Antipodes and giving to the people of Australia the diversified conveniences and comforts of man-made refrigeration. Most of us have an imperfect idea of Australia as a whole, except the general knowledge that this island continent is of vast expanse. Although Australia extends north and south through 28 degrees of latitude — its northernmost tip being only 11 degrees below the equator — still the country is subjected to fewer climatic variations than any other great continent.



Close-up of the two POC-1-A direct-connected oil-engine-driven ammonia compressors as they appeared before the plant was completed.

On the west coast, for instance, there are virtually only two seasons—the wet season, which begins in April and ends in October—and the dry season, which comprises the remainder of the year. In the southwestern section the mean temperature is about 64°F., and the summertime is therefore a period of rather high temperature. Such being the case, it is understandable why enterprising citizens of Perth, some three decades ago, saw ample warrant there for the establishment of an ice-making plant.

Since the Western Ice Company was organized, its plant has undergone a great change by reason of the increasing demand for ice and cold-storage space. Twice the plant has been rebuilt and remodeled: once because the property stood on the line of the Trans-Australian Railway and was taken over by the government, and the second time because of depreciation and lack of room for expansion. Two years ago the management acquired a well-situated block of 1½ acres with frontage on two streets; and J. L. Ochiltree was commissioned as architect for the new buildings. Cooperation between Mr. E. L. Neville, the general manager of the Western Ice Company, Mr. W. L. Patterson, the consulting engineer, and the architect has resulted in the erection of a particularly fine plant with a storage capacity of 62,000 cubic feet and two freezing tanks having a capacity of 58 tons of ice. The design is such that the cold-storage facilities can be increased and the ice-making capacity doubled to supply possible future needs.

It was Mr. Patterson's intention to create a plant that would produce ice of perfect quality at the lowest practicable fuel cost and with a minimum of handling. With these ends in view, the most up-to-date machinery has been installed. City water is available; and, in addition, the company has its own artesian wells. The water from these is first passed to a series of treating tanks, next to precooling tanks, and thence on to multiple can refillers. These refillers have been devised by Mr. Patterson, and are so arranged that they feed each can with the same quantity of water.

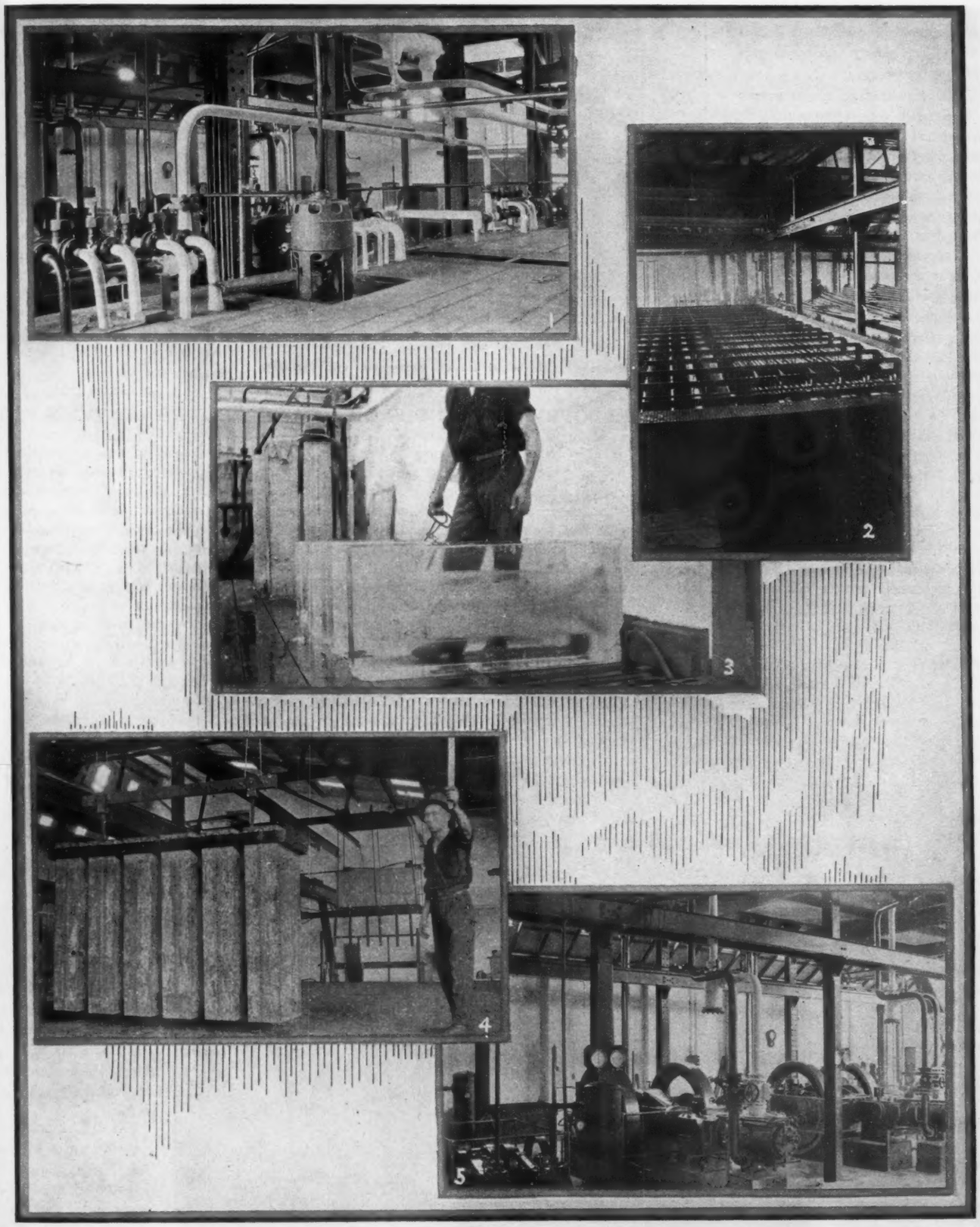
The cans are set in cradles; and there are six 300-pound cans to each cradle. Pneumatic cranes are used to transport the ice to the thawing tanks and to the tipping tables. After the ice is "harvested" it goes down gravity conveyors to an automatic ice-scoring machine which cuts the large blocks into pieces to suit the customers' demands. A Martocello high-pressure-air agitating system is employed in the early stages of the process, and, as a result, the ice produced is transparent.

All the cold-storage rooms have direct-expansion coils and, in addition, half of the compartments are supplied with circulating air that is cooled by passing over a brine battery. A multivane type of fan is utilized to force the air through large ducts free from bends or restrictions. The rooms as well as the tanks are insulated with two layers of cork board each 2 inches thick.

The refrigerating requirements are met by two 60-ton direct-connected oil-engine ammonia compressors which are installed in a spacious and well-lighted engine room. The condenser house is immediately over the engine room, and above this, in turn, is the water spray tower. The condenser house deserves special mention on account of its excellent circulation of air, to which is attributable a discharge pressure that seldom exceeds 140 pounds per square inch even on the hottest days. Water for the condenser make-up is furnished by a 3-throw pump taking water from the bore; and the condenser-water circulating pumps are driven from extensions on the main compressor crankshafts.

Ammonia condensers in an advanced stage of erection.

The heat of the engine-exhaust pipes serves to concentrate the brine from the air battery of the cold-storage rooms after the brine has become diluted by the absorption of moisture from the atmosphere. The entire plant is equipped with a system of defrosting that



1—Ammonia connections to the ice tanks and motor-driven brine agitators.
2—The ice tanks while they were under construction.
3—These blocks of clear ice are good examples of the regular product.
4—Ice cans are handled in groups of six by air-driven hoists.
5—The engine room contains two POC-1-A oil-engine-driven ammonia compressors, also an ER-1 air compressor for general pneumatic service and a smaller ER-1 unit that provides air for water agitation.

makes it possible to remove any accumulations of "snow" on the direct-expansion pipes or coils in the rooms when they are empty and being prepared for re-use.

All the cold-storage compartments are fitted with long-distance electric thermometers that register the prevailing temperatures on recording instruments in the engine room. In this way the engineer can frequently check the temperatures in the various rooms without leaving his post. All ammonia regulating valves are placed near the recorders.

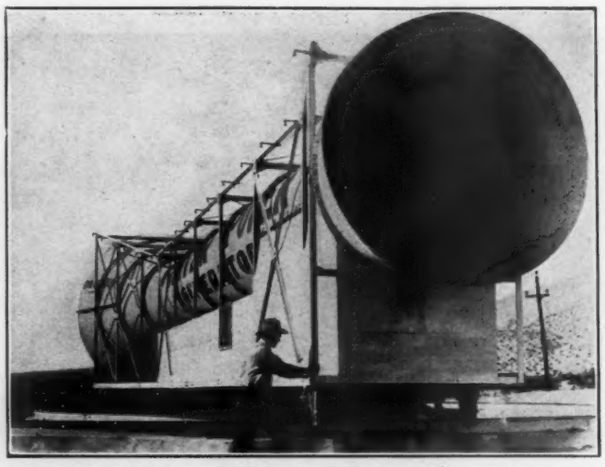
There are also two air compressors in the engine room. One of these is a low-pressure machine that supplies air for the Martocello agitating system. The other is a high-pressure unit that furnishes the power necessary to operate the hoists and the air motors of the overhead traveling cranes. This compressor likewise furnishes air for tire pumping, can washing, paint spraying, etc.

The fuel oil is stored in two underground tanks, each having a capacity of 15 tons. This is a sufficient reserve against any reasonable delay in the delivery of fuel. Before the oil is fed to the engines it is drawn through a filter by the fuel-supply pumps, which are integral parts of the engines. All the machinery and coil work in the plant of the Western Ice Company was provided and installed by the Ingersoll-Rand Proprietary, Ltd.

The two oil-engine ammonia compressors have been a revelation to the management in respect to ease of starting, control, running, and extremely low cost of operation. The owners have expressed themselves as well satisfied with their choice.

The developed water power of the world, according to the latest estimates made by the United States Geological Survey, has risen from about 23,000,000 hp. in 1920 to 33,000,000 hp. at the end of 1926. This is an increase of 43 per cent. in six years. The total is divided up as follows: North America, 16,800,000 hp.; Europe, 13,100,000; Asia, 2,100,000; South America, 750,000; Oceanica, 240,000; and Africa, 14,000 hp. The United States is in the lead with 11,721,000 hp. for plants of 100 hp. or more, and Canada comes next with 4,556,000 hp.

The United States is the world's largest producer of leather.



Courtesy, Power Plant Engineering.

It is said that this wind-driven generator can develop 200 hp.

ELECTRIC CURRENT FROM THE WIND

THIS is not a mammoth megaphone: it is a wind-power generator that produces electric current whenever the wind is blowing four miles or more an hour. This unique contrivance has been erected in southern California; and its wind motors are capable of developing 200 hp., so it is said.

As the accompanying illustration shows, the generator consists of a tunnel, lengthwise through the center of which is run a shaft carrying a series of propellers. By the aid of a huge funnel at one end, the wind is concentrated on the propeller blades, which turn the shaft at an average of 180 revolutions per minute. The entire structure is mounted on a circular track-base so that it may be swung easily any time a change occurs in the direction of the wind. Electric controls automatically keep the large funnel squarely in the face of the strongest wind. A second much larger plant of this kind is now in course of construction, and is designed to produce 1,400 hp.

The purpose of the promoters of this scheme is to build wind-power generators in different parts of a given district and to pool the current so that there will always be an ample supply even if one or more plants in the group should be idle because the wind had ceased to blow. In other words, by having a dozen or more wind-power generators within a radius of 50 or 100 miles, enough of them would at all times be in service to assure a continual supply of electricity. It is claimed that the operating costs of power plants of this type are low inasmuch as one man can take care of a number of them.

IMPROVED AIR DOGS FOR SAWMILLS

THE Martin air dog, as our readers may recall, was described some years ago in *Compressed Air Magazine*. That pneumatic device, which makes it possible to hold a log positively upon the sawmill carriage, has since then been modified by the Filer & Stowell Company of Milwaukee, Wisc., which concern has taken over the manufacture and the sale of that aid to the lumberman.

In the improved dog, the boss dog has been replaced by air-operated dogs incorporated in the knees which grasp the log or cant on the top and bottom. The advantage of this is that the boss-dog tooth marks are done away with; and, besides, small and medium-sized logs can be held more securely.

All valves on the manifold and cylinders are now provided with airtight poppet valves that use less air than the plug valves previously employed. The automatic poppet valves on the dogs and tapers are so designed as to permit adjustment to any speed desired. Automatic devices prevent the board-dog teeth and the hook dogs from advancing within the saw line. The air equipment is operated through a poppet-valve manifold by one man. Each knee is fitted with block cleaners for blowing off bark, chips, and refuse.

At the new light-and-fog signal station, built by the United States Lighthouse Service on Martin Reef in the north end of Lake Huron, compressed air is used to operate two cranes provided for handling small boats.

Here is shown an Ingersoll-Rand pneumatic sand rammer so mounted on a tripod that it can be utilized to operate a sand riddle. This form of mount makes it easy to shift the equipment to any desired working point.

How Hickory Handles for Tools are Made

The United States Dominates This Unique Industry Which Ships Its Products to All Parts of the World

By ALLEN S. PARK

THE highest grade tool handles are made of hickory. Since hickory is an exclusively American wood, the world at large looks to the United States for its best handles. Most of them are made up in this country, although considerable quantities of the wood are exported for the foreign handle-making industry.

It may be said that, in general, tools used for striking blows are provided with hickory handles. Hammers, sledges, picks, axes, and numerous others of their kind may be cited as familiar examples. The characteristic field of service of such tools is one in which the head is swung by means of the handle and then brought to a sudden stop when it meets the object against which the blow is directed. The impact produces a shock of great intensity which the handle must bear without fracturing and which it must also absorb in such wise that the user shall experience no "sting" nor other unpleasant sensation. The qualifications required of a satisfactory handle are toughness and resiliency, and hickory possesses them in greater measure than any other wood. The reason for this is that the sap gums, instead of drying out as in most woods. Moreover, hickory satisfies the demands of workmen that such a handle have a comfortable "feel;" a surface over which the hands will slide easily; and that it shall exhibit but slight tendency to splinter or grow rough after being in service for a time. In addition to its use for tool handles, hickory is preferred for golf-club shafts and wheel spokes.

Handles should be fitted into tool heads so that the grain, as shown on the end, is parallel to the line of flight of the tool head in striking. This insures maximum resistance to the impact shock. The same principle is exemplified when the baseball batsman "holds the grain up" as he takes his swing. Obviously, the liability of breakage is thereby lessened. Where the cross section of the tool-head eye has unequal axes, the handlemaker can turn out his product so that the grain assumes the proper direction automatically. Where round or equi-sided cross sections obtain, this must be adjusted in the fitting of the handle to the tool.

Such tools as rakes and hoes, and others whose use does not involve the striking of blows, do not require handles of the highest grade. Ash is a very suitable wood for their purpose. Ash is likewise employed in the poorer grades of striking-tool handles, particularly abroad, where the workmen are not so exacting as they are in the United States.

The hickory tree is said to have derived its name from the Indian word *pawcohiccora,* which was a dressing for hominy made from the milk of pounded hickory nuts. Authorities

Left—Each of these lathes will turn 3,000 handles a day.
Right—A lathe of the type used for turning straight handles such as are required for hammers and sledges.
Bottom—Pattern lathes on which axe and pick handles are turned. In the machine in the foreground is a blank in position for turning.

differ as to the number of varieties of hickory trees now found. Some say there are eight: others list as many as fifteen. They are pretty generally agreed, however, that—aside from one species in Mexico—all are indigenous to that portion of the United States lying east of the Rocky Mountains. Fossil evidence discloses that extensive hickory forests existed in Greenland and in Europe previous to the ice age; and it is reasonable to assume that the great ice caps had something to do with their disappearance from those regions.

A roughing mill and its crew of workers.

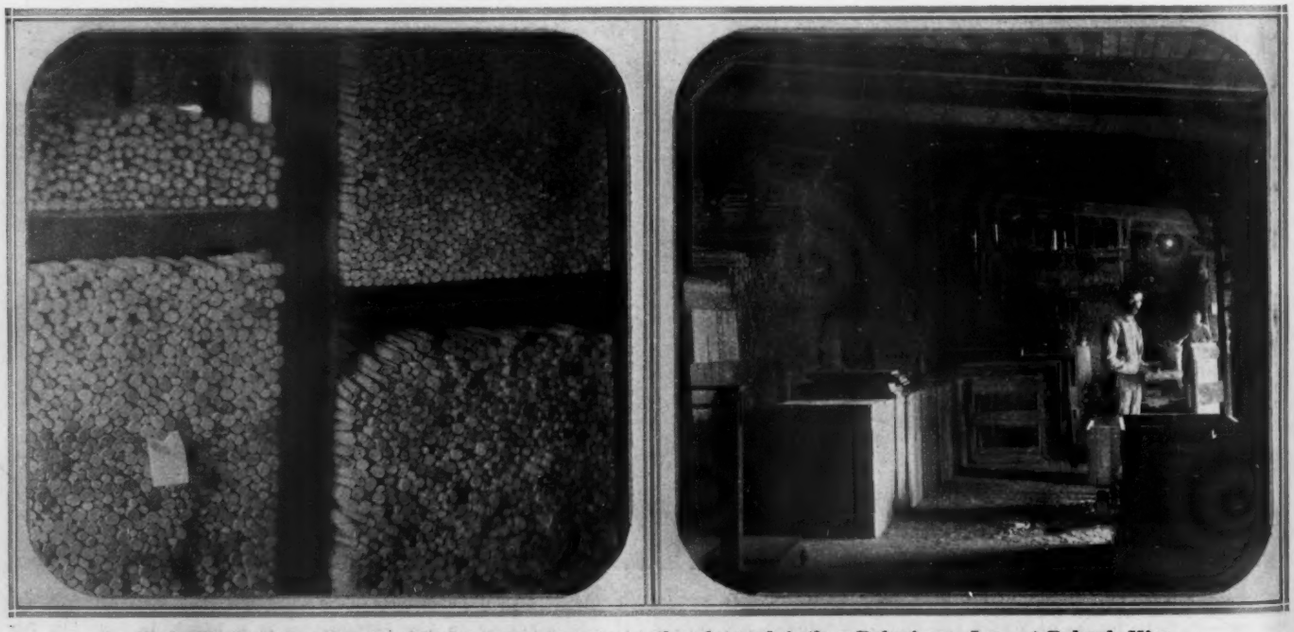
The phrase, "as tough as hickory," was coined early in American history as a fitting vehicle of expression. The qualities for which the wood is best known also suggested the sobriquet "Old Hickory," which was from time to time applied to certain of the country's leading figures that proved particularly recalcitrant. When the artificial curing of tobacco was first exploited, hickory-wood fires were preferred because they produced a steady heat, burned for a long time, and required little attention. For the same reasons, blacksmiths used hickory charcoal before coal and coke were obtainable. Hickory found favor for many other purposes. The farmer's wife husbanded its ashes as one of the desirable ingredients for her soap-making. Strips of hickory bark and splints of the wood served as materials for the weaving of baskets, chair seats, and similar articles of household furniture. Sap from the trees was popular as an ointment or liniment to "supple the joints." The Indian, and later the white man, employed rotted hickory as the best medium for starting fires by the flint-and-steel method. The red man taught the pale-faced pioneer that smoke from a hickory-wood fire imparted an exceptionally fine flavor to cured meats.

While hickory is found in various northern states, important growths for handle-making are limited to eastern Arkansas, northern Louisiana, Mississippi, and parts of Tennessee and Kentucky. The most suitable stands flourish on bottom land. The largest species is the shagbark, or shellbark. It sometimes attains a height of 120 feet and a girth of between 3 and 4 feet at the trunk base. This tree not only produces a very desirable wood but also large, richly flavored nuts.

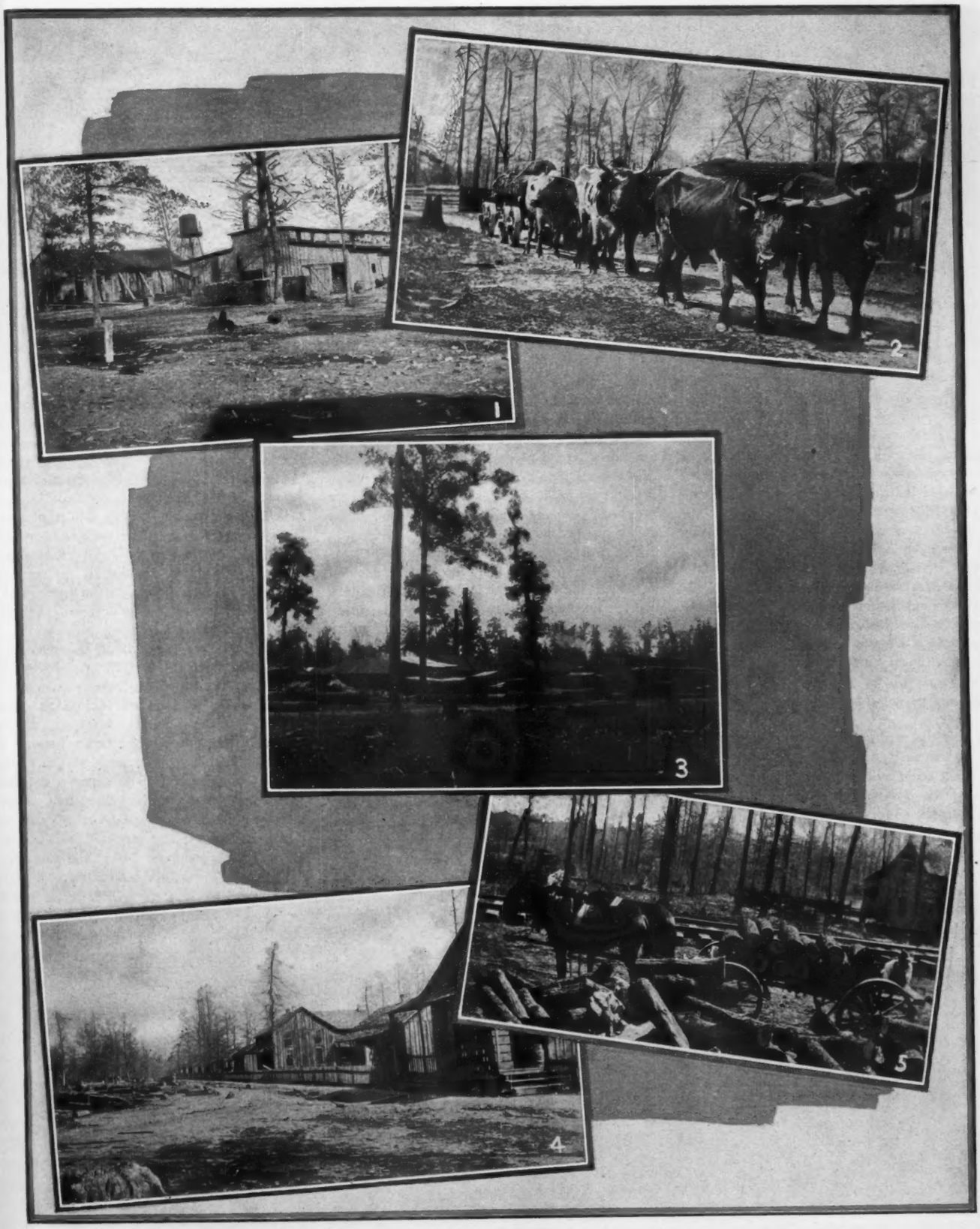
There has existed a traditional prejudice against red or heartwood hickory, based on the contention that it was inferior to white hickory, or sapwood, for handle-making. Exhaustive tests have proved this theory to be erroneous; but the prejudice has not been overcome. According to Benjamin Cook, president of Arthur Delapierre, Inc., of New York City—one of the large firms engaged in the making of handles—the trade still refuses to accept red hickory as first grade and persists in the belief that it is deficient.

The Forest Products Laboratory, which is maintained at the University of Wisconsin by the United States Forest Service, has this to say on the subject in a bulletin by Mr. Benson H. Paul:

"The color of hickory wood has nothing to do with its various strength properties, and red hickory or heartwood possesses the same desirable qualities as the white hickory or sapwood portion of the tree, in addition to being more resistant to decay than white wood. In fact, the portion of any tree which comprises its white (sap) wood today will in due time change into the red (heart) wood if the tree is allowed to continue its growth. The change in color in no way alters the structure of the wood. It results from infiltration of harmless dyelike substances among the wood elements after the work of conducting water has ceased in the inner portions of the trunk



Left—Finished handles in storage compartments at the plant of Arthur Delapierre, Inc., at Pyland, Miss. Right—Corner in the warehouse, with cases of handles packed for domestic trade.



1—Typical buildings of a hickory-handle mill.
2—Until recent years this was the method of hauling logs from the timber to the mill.
3—General view of the plant of Arthur Delapierre, Inc., at Pyland, Miss.
4—"Main Street" in a hickory town in the South.
5—Mule teams have taken the place of oxen for hauling logs to the mill.

A rough-turned axe handle as it comes from the lathe.

The same handle after it has been treated on the finishing belts.

and the task has been taken up by the newer annular layers on the outside of the tree."

The Forest Service tests show that the specific gravity or density of hickory is the best index of its quality. The wood substance of the best grades is more compact and heavier. Samples can therefore be accurately judged by weighing. Another means of grading is by noting the annular growth rings. The proportion of summer wood to spring wood is the important point to be considered. The summer wood has much greater strength than the spring wood because of its higher content of wood substance per unit volume. Wide bands of summer wood as compared to the bands of spring wood indicate strong hickory. The two are easily distinguished when observed on the end of a cut piece—the summer wood being solid looking and less porous than the spring wood. First-grade handles commonly show not more than twenty growth rings to the inch, though this rule is not infallible. Good hickory can also be identified by its oily or glossy side-grain surface when smoothly finished. Likewise, there is an auditory test, as first-grade hickory emits a clear, ringing tone when dropped on end on a hard surface, such as a concrete floor.

To give the reader some idea of the various steps in the fashioning of hickory handles, a brief description will be presented of the operations of the Delapierre Company, as outlined by Mr. Cook. The concern's activities are at present concentrated in Mississippi, and are centered around Pyland, a town built for the purpose in the midst of several thousand acres of choice timber. Most of the workers are men whose fathers were hickory-handle makers before them.

The trees are felled by sawing—the cutting being confined to the season between September 15 and January 1, when the sap is down. Trees varying in diameter from 8 to 18 inches are the sources of the choicest handle wood. After felling, they are transported to conveniently located roughing mills by mule teams which, until very recently, shared the task with oxen.

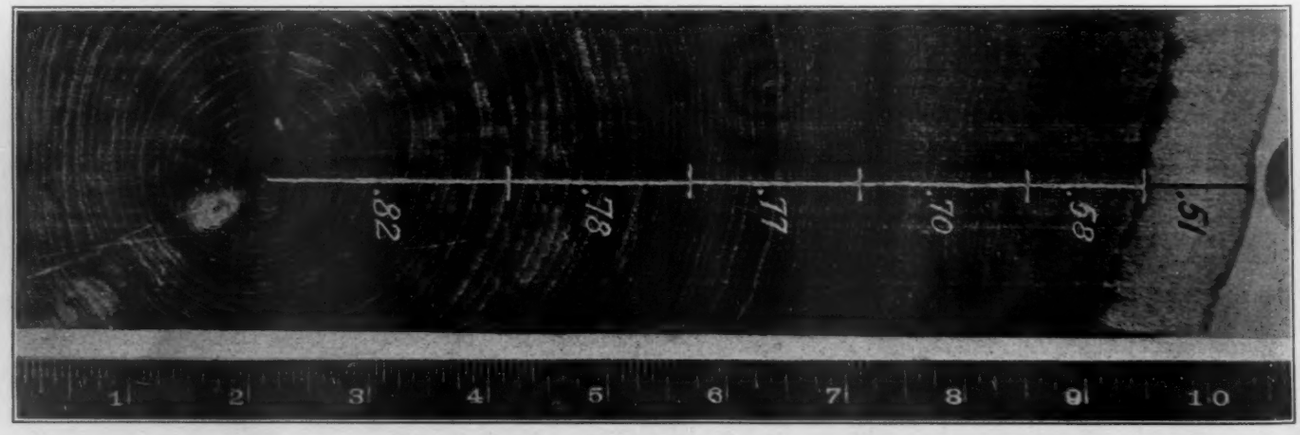
The logs are first sawed into sections, commonly 39 inches long. These sections are then cut longitudinally into flitches by slab saws. A flitch is a stick or block containing the amount of wood necessary to make one handle of the particular type for which it is intended. By means of a block saw, the flitches are roughed up to the approximate size and shape of the finished handle.

The next operation is carried on in the pattern lathe, an ingeniously contrived machine in which the rough piece of wood revolves transversely while a tool with a saw-cutter head gouges into its surface. The tool starts at one end and travels toward the other, the depth of its cut being properly varied from place to place by a pattern, which guides it.

The roughly turned handles are cut to the right length and then go to the grinding belts, which are canvas strips faced with quartz grains. The surfaces differ in texture from coarse to fine. Skilled workmen grind the pieces by hand, first on a coarsely sanded belt and then on a finer one. Next the handles are placed in drying kilns, where they are subjected to steam heat of 125°F. for a period of 60 hours. After this treatment they pass to the grading department, where they are roughly classified. From there they go back to a finishing quartz belt and to a waxing belt that polishes them. After final inspection and grading, they are packed for shipment in bales and crates.

Anyone at all familiar with the number of kinds of "handled" tools on the market will appreciate the fact that countless patterns must be provided for the lathe. There is also another factor that adds to the list of varieties of handles that must be made. This is the divergence in the style of tool heads as employed in different nations. For instance, all German-made heads have square- or rectangular-shaped eyes requiring handles with ends of similar shapes. The Spanish-type tool heads, which are widely used in South America, fit over the grip end of the handle, as do American or Yankee picks. The tool end of the handle is a trifle larger than the eye of the tool head to prevent the head from slipping off. Most Yankee tool heads, on the other hand, are made for wedging on to the end of the handle. Some handles designed for Cuban tools possess several turns or crooks.

Handle makers have found it impossible to standardize their product for the reason that the several countries become accustomed to certain styles of tools and refuse to change. It is interesting to note, however, that the superiority of American hickory handles has been a boon to the toolmakers of this country and has enabled them to capture the lion's share of the world trade. They have adapted their plants to the manufacture of any style of head desired. The standard handle length for such tools as axes, picks, and the like, is 36 inches. The standard length for hammers and similar tools is 14 inches. But handles are made in lengths of from a few inches up to 42 inches.



Section of a pignut hickory tree 180 years of age, showing the changes in the specific gravity of the wood from the center outward toward the circumference. Contrary to an old belief, the red or heartwood hickory in this tree is superior to the white hickory, or sapwood.

A first-grade hickory handle contains only straight-grained white sapwood of broad growth rings and entirely free from such blemishes as knots, bird pecks, and iron streaks. To conserve the supply of hickory, however, Mr. Cook states that his firm utilizes the remaining wood of the trees in turning out so-called second-grade handles. When an order is placed for first-grade handles of a special pattern, the buyer has to agree also to take all the lower-grade handles that result from the making up of his order. The tree tops and the larger limbs are used to make Belgian rammers, for laying paving blocks, and the various types of mallets and mauls employed by ship calkers, tinsmiths, coppersmiths, boilermakers and other craftsmen. In these, the tool heads as well as the handles are of hickory.

The extensive character of the hickory-handle business is revealed by the books of the Delapierre Company. Its representatives are in every large city of the world; and shipments are made annually to practically every country on the map. United States *Commerce Reports* show that the United Kingdom takes 40 per cent. of our handle exports, while exportations of hickory lumber for foreign handle-making totaled 4,419,000 board feet in 1925.

The Delapierre Company, Inc., was established 31 years ago. In addition to Mr. Cook, its officers are: Charles H. Cowan, vice-president and treasurer, and J. F. Swan, secretary. Business offices are maintained in New York City.

SUPER GAS PLANTS

THE suggestion that large gas plants be located in coal fields, or at the source of the necessary raw materials, is again called to public attention through the following reference to the subject, which appeared recently in the *New York Herald Tribune*. According to that newspaper:

One of the future developments in the manufactured-gas industry, discussed at the present time, is the construction of central gas plants near the country's coal fields and their connection with towns and cities by means of a comprehensive network of pipe lines. This would seem to be a practicable means of effecting economies. By this system, gas companies could serve an extremely large number of consumers in addition to cutting down freight expenses on coal.

OIL-ELECTRIC LOCOMOTIVES IN INDUSTRY

THE American Rolling Mill Company and the Donner Steel Company have each ordered an oil-electric locomotive for switching service in their yards. The Donner Steel Company will use its 60-ton oil-electric locomotive at its plant in Buffalo, N. Y.; and the American Rolling Mill Company will put its 100-ton oil-electric locomotive in service at Middletown, Ohio. A few months ago the American Rolling Mill Company bought a 60-ton oil-electric locomotive for yard work in its plant at Ashland, Ky., and the second order for a larger unit is the outcome of the excellent showing made by that 60-ton machine.

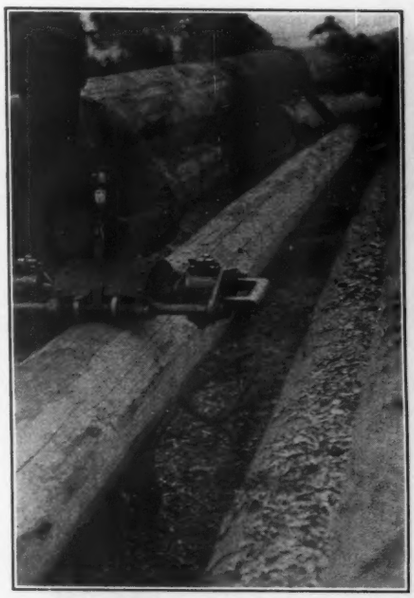
The freight-handling yard of a sizable steel plant or rolling mill calls for continual movement on the part of locomotives engaged in shifting loaded and unloaded cars and in making up outgoing trains or in breaking up arriving ones laden with essential supplies. The locomotives must start, stop, and reverse their directions at frequent intervals, and this imposes operating stresses that induce heavy maintenance charges, not to mention a very wasteful consumption of fuel when the work is done by steam locomotives.

The oil-electric locomotive is especially well fitted for duty of this sort, because it uses fuel only when in motion; and it can exert its full power at all speeds. That is to say, it is able to overcome the inertia of heavy dead loads in starting trains, and once in motion it can pick up speed rapidly. Furthermore, the oil-electric locomotive can run in either direction with equal efficiency and speed.

The primary source of power in these locomotives is one or more 300-bhp. Ingersoll-Rand oil engines—the 100-ton locomotive being equipped with two of these engines. The engines drive General Electric generators, which furnish current to operate the four motors geared to the driving wheels. In fact, all the wheels are driving wheels, and every pound of an oil-electric locomotive's total weight is effective in giving the locomotive its grip on the rails.

The two oil-electric locomotives for the steel companies in question are the joint products of the Ingersoll-Rand Company, the General Electric Company, and the American Locomotive Company.

This 60-ton oil-electric locomotive has performed so well at the American Rolling Mill Company's plant in Ashland, Ky., that the company has ordered a 100-ton unit of the same type for its plant in Middletown, Ohio.



This pole planer is driven by two pneumatic grinders, mounted on the same shaft and running in opposite directions.

Work on Cuba's great 700-mile central highway has been progressing rapidly. The engineers in charge estimate that about one-fifth of the construction on the main road was completed in 1927. Grading, the making of hundreds of concrete culverts, the replacing of roadside trees, etc., have, in the main, been finished.

A rush order of rivets was recently shipped by airplane from Chicago to Iowa City, a distance of 236 miles, in less than two hours—enabling the contractor to go on with his work the same day the consignment was forwarded.

Good Roads Opening Wilds to Sportsmen

By G. W. MORRISON

BECAUSE one out of every five of us in the United States owns an automobile, we have become familiar with the splendid work that has been and is being done by the roadbuilder. Great transcontinental highways make it possible for the motorist to travel in comfort from coast to coast; fine, broad state roads speed up traffic between important centers; and improved county roads are gradually opening up to the traveling public the byways—the rural and the wooded districts that attract the nature lover, the fisherman, and the hunter.

Because of the portable compressor and pneumatic tools the contractor can build modern highways in rugged and out-of-the-way places with little difficulty.

The State of Pennsylvania has been especially progressive in developing its county roads. In the Pocono Mountains, for example, most of the roadways that existed there a few years ago were narrow, winding, rocky wagon trails that could be negotiated by automobile only in dry weather. Nowadays, many of them have been widened, graded, and in some cases surfaced.

This work has been greatly facilitated by portable air compressors—those self-contained power plants that can be taken into the most inaccessible regions and be made ready in a few minutes' time to furnish the air necessary to operate the pneumatic tools on which the roadbuilder has come to depend. Besides "Jackhamers," used for drilling boulders and outcropping ledges of rock, he employs paving breakers for loosening shale and cutting out stumps, and clay diggers for other sorts of excavating. Some of the portables are also provided with air hoists which have proved so helpful in doing the heavy lifting and shifting usually associated with jobs of this kind. With the aid of a portable and suitable air-driven tools, it is possible to finish in a few hours work that would require days to complete if done by hand labor. It is because of the advantages they have to offer that portable compressors, particularly the 4¼x4-inch or the 5½x5-inch type, are today included in the equipment of nearly every road-building contractor and highway department.

In the spring of 1927, the writer took his car over a road in the Poconos that was then undergoing improvement. This roadway penetrates one of the finest deer-hunting regions in Pennsylvania; and, when the season is on, is much traveled by sportsmen that come from every section of the eastern part of the state. Deer were scarce in those mountains not so long back; but, thanks to the efforts of the State Board of Game Commissioners, the hunter now has a good chance of taking home a buck. It has been reported that more than 10,000 bucks were shot, legally, in Pennsylvania during the last hunting season; and one of the two men in the accompanying picture, shown carrying a beautiful 7-prong buck, said that he had counted 64 does and young bucks in the course of the seven days that he was in the woods.

Another member of this hunting party, Mr. Francis Houstin, Jr., of Easton, Pa., bagged this 7-prong buck within an hour after the season opened last fall. Being a modest man he insisted on taking the picture.

The road leading into this sportsmen's paradise is now twice its original width, is well graded, and all sharp curves have been straightened out. The development of our county or rural roads has been given an impetus by the organizing last year of the County Highway Officials Association. The object of this organization, in which each of the 3,070 counties in the United States is represented, is to do for the counties what the American Association of State Highway Officials has done for the states.

SPEEDING PLANT GROWTH BY USE OF ELECTRICITY

SWEDISH farms are gradually being electrified as the result of a system of rebates on current for farm use introduced in 1923 by the water-power administration. Since then the consumption of electricity in that branch of industry has increased 40 per cent. Besides being utilized for lighting and for operating machinery of one sort or another, its most interesting service is in stimulating plant growth.

At the present time, a little less than 6,000 square yards of electrically heated beds have been given over principally to the growing of vegetables—the largest individual holding of this kind, near Stockholm, covering an area of 1,500 square yards. So satisfactory have been the results that the wiring is to be extended over 900 additional square yards.

It is instructive to learn that it has been possible by this method to harvest a crop of vegetables 40 miles north of the Arctic Circle as early as March 28. While most of this work has been done under cover, still experiments have proved that produce can be raised in open fields charged with electricity. But this is prohibitive at the present time owing to the costs of wiring and power.

Motor Trucks Designed to Carry And to Mix Concrete

WHEN concrete is mixed at one point and transported by motor truck to another point for pouring it often causes unsatisfactory work. And the likelihood of undesirable results grows directly with the lengthening of the time between mixing and pouring. This is because gravitation operates without cease, and the various ingredients of the batch tend to separate and to rearrange themselves in the order of their unit dead weight. When subsequent handling, after dumping from the truck, does not remix the concrete sufficiently, then this separation or segregation, as the case may be, impairs the uniformity of the molded mass.

General view of the plant at which the combined truck and concrete mixers are loaded with sand, gravel, cement, and water.

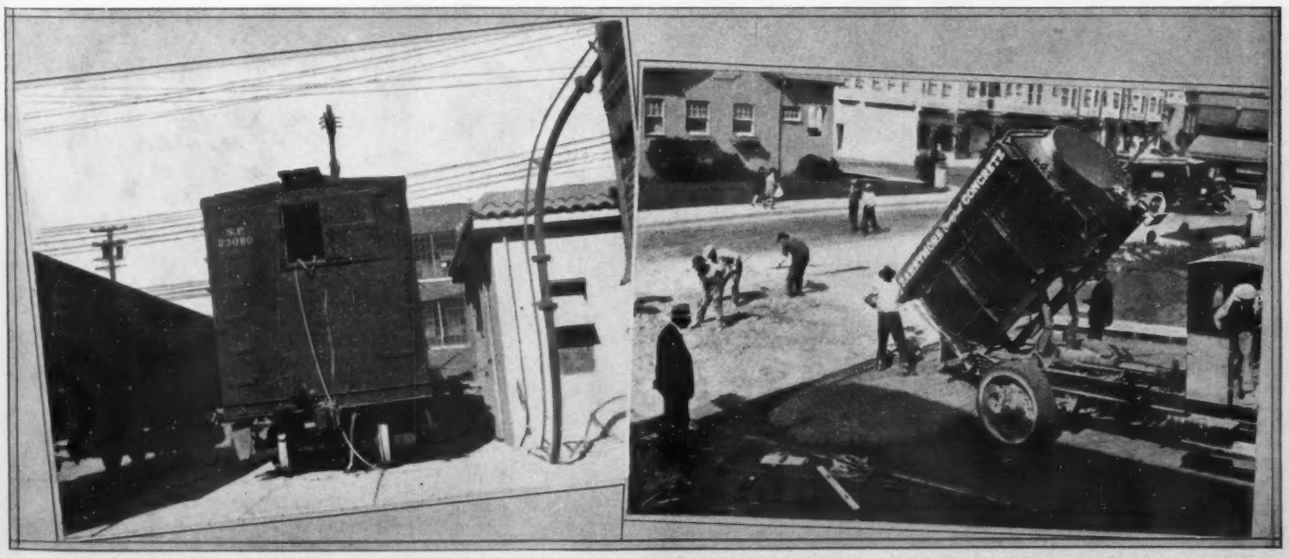
With this prelude, it will be easy to understand the reasons that have led to the development of motor vehicles that are combined truck and concrete mixers. That is to say, the dry batch ingredients, properly proportioned, are put into a special form of motor truck, and the water is not added to the batch until just before the load is dumped at its destination. This mixing process is controlled by the truck driver; and power to operate the mixer is furnished by the truck motor—the motor being brought into play by a suitable clutch.

Trucks of this kind are now in service in a number of cities; and our illustrations show those used by the Golden Gate Atlas Materials Company, of San Francisco, Calif. It is said that this method of delivering truck-mixed concrete at the job saves the contractor or builder many worries. It also prevents vehicular congestion at the building site by making it possible to have the storage bunkers for sand, gravel, and cement placed at some more or less distant point, or where they will not interfere with the structural activities.

All the contractor has to do is to plan his construction schedule and then to order truck-mixed concrete according to that program. If unforeseen circumstances arise it is only necessary to telephone to the building-material yard to stop truck arrivals until further instructions. While thus effecting operating economies and insuring a proper flow of the needful concrete from the yard to the building site, the contractor is also assured that the concrete, as delivered, will conform strictly to specifications. This is because all batching and measuring of the ingredients, as well as the water, is done at the material yard by experienced concrete men. There is little chance for error or change from the specifications. The aggregates and the concrete are transported dry to the job, and there is no reason to worry over possible precrystallization or separation of the solids and the fluid.

The driver has complete control over the mixing mechanism, the addition of the water, and the dumping operations of the truck. Water is admitted to the batch from the tanks on the truck through six special valves; and these can be adjusted to deliver the prescribed quantity of water for the particular batch. To empty the concrete, the driver disconnects the mixer from the driving mechanism, engages the hoist, and tilts the vehicle by raising one end of the body. It takes but a brief while to mix the dry materials and to admit water gradually as the batch is being churned; and this can be done without occasioning delay after the truck has reached the building site and is awaiting its turn to discharge. The truck-mixed concrete is poured in about two minutes after the mixing is started.

The Golden Gate Atlas Materials Company



Left—The cement is forced by compressed air through a large pipe, seen at the right, and discharged into overhead storage bins. Right—Concrete for street work being delivered by a combined motor truck and mixer.

Close-up of the concrete-loading plant. Compressed air raises the cement to overhead storage bins.

operates a fleet of these combined truck and concrete mixers in supplying ready-mixed concrete for construction work of different kinds; and it has recently completed a large and modern plant for the measuring and loading of cement, rock, sand, and water into these vehicles. Various aspects of this plant are shown in the accompanying pictures.

Compressed air is used there in handling the cement, which is received in carload lots. The cement is unloaded directly into an underground hopper over which the cars are spotted, and the hopper feeds the cement into a machine where it is picked up and forced by compressed air through a large pipe that delivers the material to overhead steel storage bins. From these and similar bins, the cement, sand, gravel, or crushed stone are discharged, in properly measured quantities, by gravity into the combined truck and concrete mixers.

Assuming the specifications to be correct, it is now possible for architects, engineers, and builders to guard against one big promoting cause of concrete failures by utilizing truck mixers of the character described. Manifestly, every bit of sand, all rock or other aggregate, the cement, and the duly prescribed amount of water are carried to the job in a condition that cannot occasion trouble —and, when at the point of use, they are mixed immediately before pouring.

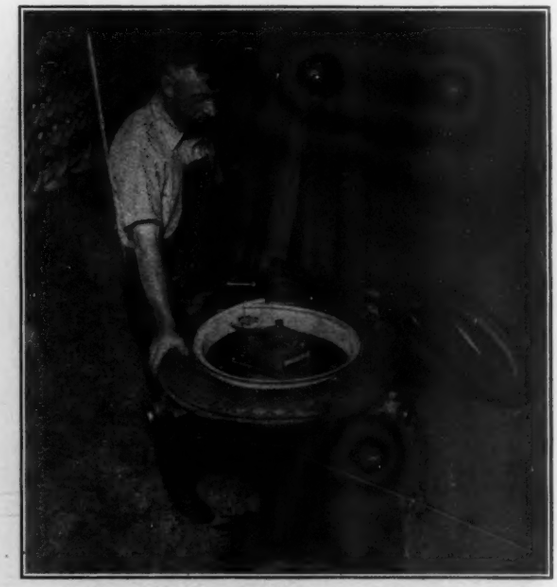
During 1927, for the first time in the history of Newfoundland, the total value of her pulp and paper products equaled that of her fisheries—each approximating $13,500,000. Last year, with an output of 200,500 tons, Newfoundland outranked Norway in point of production.

OUTPUT OF POWER RISES AS PRODUCTION COSTS FALL

ESTIMATES of the total annual production of electricity by public-utility power plants in the United States, as given out by the United States Geological Survey, indicate an output of 79,724,000,000 kilowatt-hours in 1927, or an increase of 8 per cent. over the 1926 figures. Of this quantity 37 per cent. was generated by the use of water power—a gain of 1.6 per cent. over 1926. In kilowatt-hours, the current produced by fuel and by water power increased about 5½ per cent. and 13 per cent., respectively. It would have required approximately 27,000,000 tons of coal to generate the block of energy obtained in 1927 from our falling waters.

The improvements that characterized the utilization of fuels during the last few years, and which are mainly attributable to betterments in plant design and in plant operation, were continued in 1927. In that twelvemonth, as compared with 1926, public-utility power plants performed the remarkable feat of generating about 2,500,000,000 more kilowatt-hours with 150,000 tons less fuel.

From 1919 to 1927 the amount of coal needed to produce a kilowatt-hour of electricity decreased from an average of 3.2 pounds to 1.8 pounds. This performance is notable for two reasons: first, because of the extent of the reduction in the 8-year period—namely, 1.4 pounds of coal, or a quantity nearly as large as the present average rate of consumption per kilowatt-hour; and, second, because it was believed that the highest efficiencies had been reached under the existing conditions of generating electricity. From 1926 to 1927 the reduction amounted to about 0.12 pound of coal per kilowatt-hour produced. This apparently insignificant gain resulted in a saving for the twelvemonth of approximately 3,000,000 tons of coal, valued at $12,000,000.



A tire-changing machine in the plant of the Paige Detroit Motor Car Company. The machine is operated by an air-driven Ingersoll-Rand reversible drill.

REFRACTORY BRICK OF NEW FORM

A NEW type of fire brick is being manufactured by the General Refractories Company that will add measurably to the strength of the whole structure because of its form, according to *Mining and Metallurgy*.

"Biasbrix," as the name implies, is a unique-shaped refractory that is laid on the bias—one brick overlapping and tying together three others in a natural self-locking construction that gives exceptionally tight joints and a wall of great strength. On account of this, it is claimed that the walls do not loosen up, joints remain tight, and heat losses and slag penetration are reduced to a minimum.

While "Biasbrix" are different in shape, they can be laid as readily as the ordinary straight brick in any thickness of wall from 4½ to 27 inches or more, and are equally well adapted to large or small installations. Particular emphasis is placed on their worth in hollow-wall construction, where a strong bond is essential.

A new acid and waterproof cement has been put on the market in England that is especially suited for lining acid and process tanks, vats and sumps, and other kindred structures. The material, which is sold under the name of "Prodorite," is said to be noncorrosive, nonporous, and nonconductive, and is unaffected by concentrated hot or cold hydrochloric acid. Official tests of the cement—made up of standard materials —have given a crushing strength of more than 6,000 pounds per square inch, so it is claimed.

World's Deepest Mine

The Village Deep Gold Mine In South Africa Has Reached a Vertical Depth of 7,630 Feet

By OWEN LETCHER

THE greatest depth to which man has delved anywhere in the world is in the Village Deep Gold Mine, just to the south of the Township of Johannesburg, on the Central Witwatersrand.

In the subincline, from the Turf Shaft of this property, an extreme vertical depth of 7,630 feet below datum line—which is the mean average elevation of the Witwatersrand above sea level—has been reached. The vertical depth below the collar of the shaft is 7,264 feet, representing the equivalent of nine Woolworth Buildings, one superimposed on top of the other until an edifice has been created soaring into the sky for a height of between a mile and a quarter and a mile and a half.

Johannesburg stands in the center of a lofty plateau, with an elevation of about 5,800 feet, so that the Turf Shaft—in the heart of the Union of South Africa—has penetrated to a depth of about 1,800 feet below sea level. This is a colossal achievement that invites contemplation; and it may, in the first place, be asserted that the task of sinking to such an enormous depth has in large degree been rendered possible through the use of compressed-air drills. The machines employed at this great depth are five Ingersoll-Rand DCRW 23's. The ground is exceedingly hard. At present a footage of from 40 to 50 feet per month is being obtained; but, later on, when it is desired to accelerate this footage, 100 feet per month will, it is believed, be secured. The air pressure at the face is about 85 pounds per square inch.

How much deeper will operations at this remarkable and difficult mine be conducted? One cannot give any definite answer to this question. As already explained in an earlier issue of this Magazine,* the future of the Village Deep depends upon the economic factor. No substantial enrichment of the ore is to be expected; and, therefore, the question as to what eventual depth will be attained must depend upon the ability of the management to keep working costs down to a reasonably low figure.

As the Village Deep Mine is constituted today, three more levels can be opened out before the extreme southern boundary of the company's property is reached. This would mean the driving of the forty-second level at a vertical depth of about 8,000 feet. Beyond this is further ground which could no doubt be acquired by the company. Again we would emphasize the point that the determining factor will be the economic one; but it can here be remarked that, given reasonably favorable conditions, mining at a vertical depth of 8,000 feet in this ultra-deep Central Rand proposition during the next year or two is quite within the bounds of probability.

In the lowest workings of the Village Deep the temperature of the rock is about 97° F; and the air temperature is reduced by cooling to 85° F. Ventilation is secured by a large Sirocco fan; by the direction and the control of air currents through bratticing; and by keeping open the old No. 2 Shaft which forms the main upcast of the mine. Heavy expenditure is entailed in the maintenance of this No. 2 Shaft for the purposes of ventilation and of providing a second outlet from the workings.

In order to reduce the air temperature in the lowest levels, 4 tons of ice are sent underground every 24 hours, namely, 3 tons on the day shift and 1 ton at night. This ice is placed in the main air column; and the air from the surface flowing over the ice blocks induces a reduction in temperature of about 12 degrees.

The main ventilating column is 15 inches in diameter, and is carried right down as near as possible to the bottom of the shaft. The bottom of this shaft, it may be remarked, is not in the reef, but in a hard, dolerite dike. This dike has been encountered from the thirty-seventh level downward, and has resulted in a displacement of strata equivalent to one level —that is to say, for a distance of 300 feet on the incline, or a vertical displacement of 160 feet. The dike causes an upthrow, and this means that there is a duplication of strata in this section of the Village Deep property and, therefore, an additional tonnage per claim.

The descent from the collar of the Turf Shaft to this immense depth of nearly a mile and a half is achieved in four stages—the whole downward journey occupying about twenty minutes. These are: first stage, a

*Rand Mines Owe Much to "Jackhamer," November, 1927.

Stoping with "Jackhamers" in South African gold mines.

Drilling with Ingersoll-Rand drifters on the thirty-eighth level of the Village Deep. Manifestly, the temperature is high that far underground.

vertical shaft from the surface to the eighteenth level at a depth of 4,000 feet below datum; second stage, an incline shaft from the eighteenth to the thirty-third level at a depth of 6,570 feet below datum; third stage, an incline shaft from the thirty-third to the thirty-ninth level station 7,561 feet below datum; and, fourth stage, concrete steps for 100 feet on the incline, inside an incline shaft, from the thirty-ninth level to the bottom of the shaft at a vertical depth of 7,630 feet below datum, or 1,830 feet below sea level.

It should here be explained that there is an overlap of two levels in the third stage of hoisting in order to allow the ore from the deepest subincline to gravitate into the ore bins supplying the second-stage hoist. The stage hoists are: first, a surface engine at the collar of the Turf Shaft; second, three hoists on the seventeenth level; and, third, three hoists on the thirty-first level. Below these is the sinking hoist, which is located on the thirty-sixth level. All hoists are electrically operated.

The four deepest gold mines in the world are the Village Deep and the City Deep both on the Central Witwatersrand; the St. John del Rey, in Brazil; and the Champion Reef in Mysore, India. Both the St. John del Rey and the Champion Reef are, however, being worked on a comparatively small basis: the Village Deep is easily the deepest gold mine in the world that is being operated on a big scale. Not only are these enterprises the deepest workings for gold but they represent the greatest depths to which man has burrowed in his search for any form of mineral wealth.

The Village Deep illustrates the gradual triumph of the engineer over the factor of great depth. This conquest has been a continuous and an increasing one, and has been in progress for a quarter of a century. Since the days of the historical discussion on deep-level hoisting in 1902-1903—when a more or less definite plan of deep-level exploitation was reached by a committee of the Rand's technical men—much water has flowed under the bridge of time, and conditions now are substantially different from those that were investigated twenty-odd years ago. At that date, for instance, trade unionism had not attained to the position of power and importance that it possesses at present; and the problem of the incidence of the 8½-hour bank-to-bank shift did not press as severely on considerations of working or questions of policy as it does today.

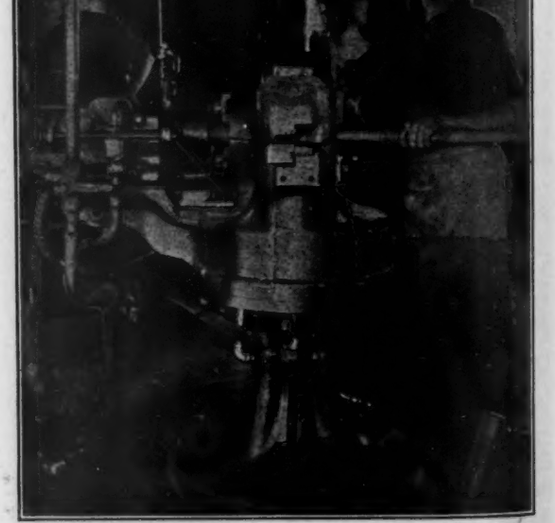
The requirements of the 8½-hour shift mean that employees in reality work only 8½ hours less the period of time which is occupied in lowering them to and hoisting them from the levels and the time spent in getting to and from the working places. Obviously, this is a troublesome problem when it concerns a mine like the Village Deep. Every day the company has to lower and hoist over 3,500 natives and 260 white men to and from an average depth of 6,300 feet!

Then, again, it was not realized in 1902 that the earth pressure exerted by the superincumbent strata would necessitate the expenditure of so much time and money for the purpose of securing the workings, or that so much labor and capital would have to be devoted to ventilation. Against these natural and artificial hindrances the engineer has backed his talent. He has, for example, availed himself of the advantages of rapid electrical hoisting, which has been common along the Rand for several years. This has assisted the management of the Village Deep very materially in successfully dealing with a mining proposition that extends so far below the surface, for electricity is a power especially suited to stage hoisting.

The evolution of a system designed to overcome these and other difficult problems has taken many years; and it is a tremendous tribute to all associated with the mining industry in general, and with the Village Deep with its low-grade ore in particular, that it is possible profitably to mine this low-grade ore at the great depth reached today. Even as it is, the margin of profit is so small that the property, with its single shaft and one payable reef, has to be run like clockwork and on the time-table principle of a railway.

At the Village Deep Mine, stoping operations are in progress at a vertical depth of between 6,000 feet and 6,700 feet below the collar of the Turf Shaft—that is, no ore is now being fed to the mill from a lesser depth than a mile from the surface; and more than 1,000 feet below the average stoping depth development operations are underway.

The problem of supporting the hanging wall or roof of these workings constitutes one of the greatest of the numerous difficulties with which the management of the Village Deep has to contend, and great care is at all times exercised. The nature of the ground at the maximum depth reached is interesting. In reality, the strata below 7,000 feet are just as secure as those at 4,000 or 5,000 feet; but, on account of the artificial cooling arrangements which reduce the temperature at the lower levels by about 12 degrees, the exposed portion of the rock is continually contracting and



An air-driven "Leyner" sharpener in a blacksmith shop in the Transvaal, South Africa. Pneumatic sharpeners are used extensively there in conditioning steels for rock drills.

Turf Shaft, of the Village Deep Gold Mine Company, which has reached a depth of 7,630 feet. It is the deepest shaft in the world.

scaling off. This means that the fractured sections in the "hanging" have to be continually "pinch-barred" down. Moreover, timbering has to be kept as close to the working face as possible. In mines of lesser depth on the Witwatersrand timbering is seldom advanced to within a few feet of the face; but at the Village Deep permanent sets have to be placed to within 8 or 10 feet of the face.

In considering the Village Deep and the difficulties attendant on winning gold from it at a profit, it should be borne in mind that in most other Witwatersrand mines two or more reefs are generally payable. In the Village Deep, however, only one reef—the main-reef leader—is profitable; and as this reef is seldom more than 2 feet in thickness it has to be very cleanly mined. In other words, it has to be broken with as little barren rock adhering to it as possible, and as much of this barren rock as is economically practicable has to be rejected in the mine. A further rejection is made at the surface; but, obviously, the tramming of rock which contains no gold is an unprofitable operation. The Village Deep is a proposition of such fine margins that everything possible has to be done to keep expenses down and to keep the value of the ore up.

The Village Deep today is thus not only a 1-shaft mine but it is a 1-reef mine as well, for the company's sole reef asset at present is this band of conglomerate, rarely more than 2 feet thick, which is known as the main-reef leader.

The European employees in the Village Deep Mine are paid a minimum basic wage that is fixed by the industry; and, in addition to this, they are given substantial bonuses which enable them to very considerably augment their earnings.

The various aspects of what may be termed industrial hygiene are most carefully watched at the Village Deep. Sanitation underground has been organized on remarkably effective lines. There is an abundance of water always available at all working faces for wetting down the ore and for eliminating dust. Drinking water, from the surface, is also supplied at all working levels.

A scheme for the development of an advisory weather service for aviators is being worked out at the Canadian meteorological headquarters in Toronto, Ont., that is expected eventually to result in a network of specially equipped observatories extending all the way from Newfoundland to British Columbia. The system is being designed primarily to aid air-mail service via the Gulf of St. Lawrence and to guide the gigantic dirigible that is scheduled to fly from England to Montreal this summer.

CODES TO GUIDE AGAINST DUST EXPLOSIONS

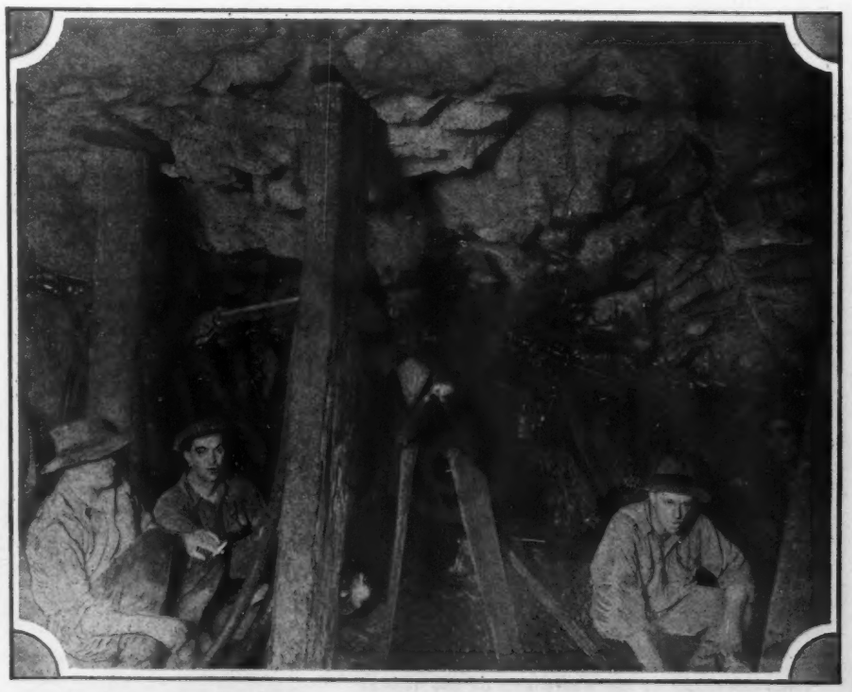
A recent census of manufacturers shows that there are in the United States 28,000 plants exposed to the hazards of dust explosions. These plants have an annual production valued at $10,000,000,000, and employ more than 1,300,000 people. Extensive research into the causes of dust explosions by the United States Bureau of Chemistry and by the National Fire Protection Association have led to the preparation of safety codes, and these have latterly been adopted as standards by the American Engineering Standards Committee.

These codes are designed for the prevention of dust explosions in terminal grain elevators, flour and feed mills, starch factories, in the pulverizing departments of sugar and cocoa mills, and in pulverized-fuel systems. Kindred safety measures for numerous other dust-promoting industries are to be outlined as soon as investigations now in hand have been completed.

ENGINEERS OF WORLD TO MEET IN TOKYO

SEVENTY-EIGHT of the nation's most prominent engineers and scientists, appointed by Secretary Herbert Hoover as honorary chairman, have accepted membership on the American Committee of the World Congress of Engineers to be held in Tokyo in November of 1929. This permanent committee will promote the aims of the movement and arrange for the attendance of American engineers at the congress.

As set forth by Baron K. Furuichi, president of the Engineering Society of Japan, the congress is the first one of its kind ever to be held, and will have for its purpose the promotion of international coöperation in the study of engineering in all its branches and the stimulation of a sense of brotherhood among engineers the world over. Government departments, universities, institutes, and associations interested in the science are invited to take part in the sessions, which will cover a period of two weeks and deal with such subjects as structural work, shipbuilding, mining and metallurgy, fuel, heating and ventilation, illumination, drainage, refrigeration, etc., etc. The entire enterprise is under the sponsorship of the Japanese Government.



"Jackhamers" at work on the 7,364-foot level in the Village Deep Mine.

Making Fine Progress on Marathon Tunnel in Greece

By A. VAN DER PLAS

ATHENS, Greece, has under construction a thoroughly modern water-supply system; and thus this ancient center of classical pre-eminence is to be brought up to date in a matter touching intimately upon the welfare of its citizenry. This important work is being carried out by an American concern, Ulen & Company, of New York City. The main features of the undertaking entrusted to this internationally known engineering and construction firm are a great dam in the hills not far from Athens and a water-supply tunnel that will convey the water from the impounding area to the city's distributing system. The tunnel, when completed, will have a length of 8.7 miles.

The tunnel is being driven simultaneously from both ends of the project; and the tunnel line lies in a generally north and south direction. At the south end the tunnel has penetrated a clayey formation; and air-driven clay diggers have been used effectively in excavating this material. Where the tunnel passes through clay the conduit is lined with concrete blocks, as shown by one of our illustrations. The same picture also serves to give a good idea of the size of the tunnel section.

At the north portal the tunnel penetrates schist, and this rock is not hard enough for the successful employment of pneumatic drifters. Excellent progress, however, has been made by drilling it with "Jackhamers." How well the "Jackhamers" have done their work can be gathered from the fact that the heading has been advanced as much as 42.97 feet in a day. All mucking has been done by hand; and the cars used in moving the muck have been hauled by mules. This end of the tunnel has been timbered as the heading advanced. In breaking the schist the consumption of dynamite has been low—amounting to a trifle more than 2.2 pounds for every 35.31 cubic feet of rock removed.

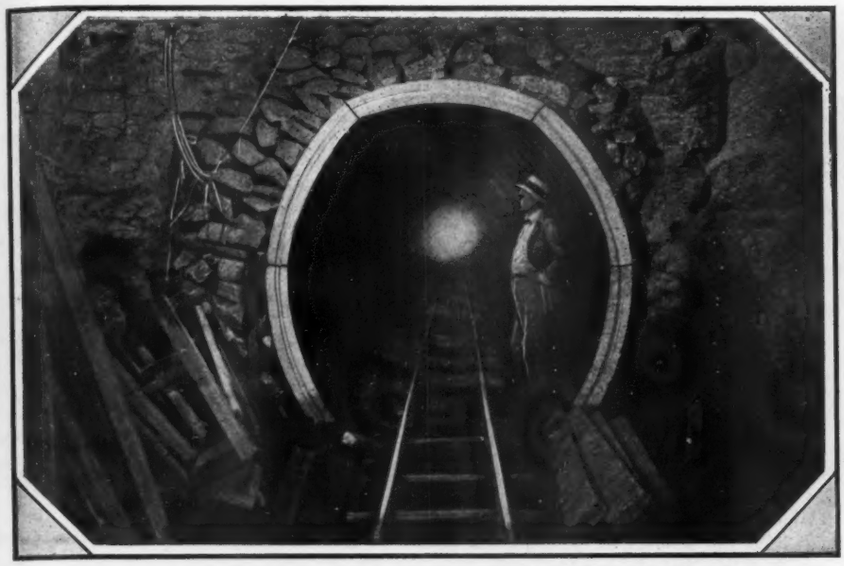
South portal where the tunnel penetrated clay formation.

In order to insure perfect ventilation of the tunnel, Chief Engineer R. H. Keays has resorted to the expedient of drilling holes from the top of the tunnel to the surface of the ground at intervals of about 1,000 feet back from the headings. These holes have been utilized to facilitate the withdrawal of foul air—fresh air being delivered to a heading by means of a blower. As the tunnel progresses, a new air vent is drilled in the tunnel top, and the blower is moved forward to the new point of operation—thus obviating the need and the expense of more and more piping as the tunnel lengthens.

The finished tunnel section has an area of about 75 square feet. On an average approximately 17 holes are drilled at each round, and of these four are cut holes. Two DCR-23 "Jackhamers" are employed at the face; and Sandviken steels, having cross bits, are used. The drilling time for a round is generally 1½ hours. "Leyner" sharpeners keep the drill steels fit for their work. The prevailing practice is to blast twice during each 8-hour shift.

The compressed air required to operate the tools is delivered to each heading through a main line made up of 2-inch rubber hose, and from this the air is fed to the face through two 50-foot lengths of 1-inch hose, which are directly connected with the rock drills or the clay diggers, as the case may be. Two automatic oilers in the line serve to insure the continual lubrication of the "Jackhamers." This

Left—Heading at the north end of the tunnel.
Right—Ingersoll-Rand air-driven clay diggers did effective work at the south portal where the tunnel passed through clay.



How the tunnel at the south portal appeared after it was lined with segmental blocks of concrete.

provision has made it possible to keep the bill for drill repairs very low.

Superintendent Hamilton, who is immediately in charge of the tunnel driving, has had the task of breaking in his working force, which is composed entirely of native labor. That he has achieved this in a thoroughly satisfactory degree is evidenced by the rate of progress made under his supervision. The men are on a bonus system; and this system has enabled the workers to earn more than double the standard wages paid laborers in Athens. The appended table shows the progress made, during a span of 5½ months, at the north end of the tunnel. It is an excellent record.

	Days		Daily Average	Daily Maximum
July, 1927...	31	633.20 ft.	20.33 ft.	30.17 ft.
Aug. " ...	31	748.03 "	24.27 "	34.76 "
Sept. " ...	30	784.11 "	26.24 "	39.69 "
Oct. " ...	31	895.66 "	28.86 "	42.97 "
Nov. " ...	30	862.85 "	28.86 "	39.37 "
Dec. " ...	12	351.04 "	29.19 "	39.37 "
	165	4,274.89 "	25.91 "	42.97 "

The second International Conference on Bituminous Coal, to be held under the auspices of the Carnegie Institute of Technology, Pittsburgh, Pa., is scheduled this year for the week of November 19. The subjects to be considered will include the latest development in obtaining substitutes for gasoline from coal, power from coal, low- and high-temperature-distillation processes, smokeless fuel, gasification of coal, utilization of coal-tar products, coal in relation to the production of fixed nitrogen, and synthetic fertilizers from coal.

Approximately $200,000,000 is spent annually in the United States for industrial research. Of this sum the Government expends $1 for every $2 laid out by industry.

ELECTRIC ENERGY FROM THE SNOW-CLAD HIMALAYAS

AS a result of exhaustive surveys made by the British Government, the latent power of the Himalayan Mountain streams is to be put to work in generating electric energy. The first plant is to be at Shanan on the Uhl River, a tributary of the Beas that flows through the Kulu Valley.

The waters of this snow-fed stream are to be conveyed through a tunnel; and they will have a drop of 1,800 feet before reaching the turbines. The station is designed to generate 200,000 hp., although more than half again as much could be produced by another available head of 1,200 feet. Besides furnishing current for a much-needed electric line, the power will be used to irrigate more than 100,000 acres of land in the Kulu Valley, to that extent helping to develop the district.

A wood oil has been produced in Denmark that is said not only to prevent dry-rot but to make wood fireproof.

In a recent address before the American Institute of the City of New York, an organization of inventors, Dr. A. B. Hitchins proposed a new method for studying iron, steel, and nonferrous metals. In this method, a special moving-picture camera is the principal instrument used, and this is aided, as may be required, by the microscope, X-ray, fluoroscope, telephoto lens, various screens which will permit only certain rays of the spectrum to pass, and specially sensitized emulsions for recording rays not visible to the naked eye. It is said that this new camera will take 3,600 pictures or 200 feet of film per second, as against 16 pictures with the ordinary "movie" camera.

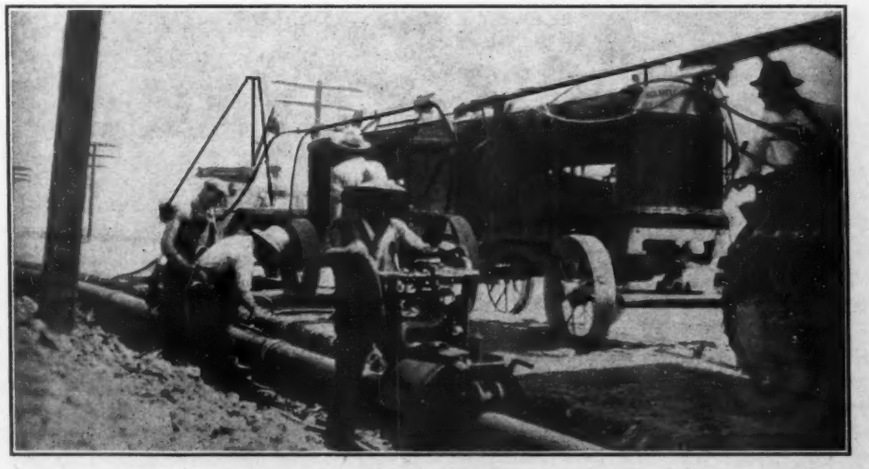
Preliminary figures published by the United States Bureau of Commerce have placed the world production of petroleum during 1927 at 1,254,000,000 barrels—an increase of 156,000,000 barrels or about 14 per cent over 1926.

COMPRESSED AIR USED IN CLEANING PIPE LINES

COMPRESSED air is used in the annual "house cleaning" of California's vast network of oil pipe lines. This cleaning is essential wherever those arteries traverse corrosive alkaline soils. Gangs of men are continually engaged in this work of maintaining the pipe lines in fit condition to carry the crude oil from the fields to the refineries.

The equipment utilized consists of a special air-operated tapping machine, of a pneumatic hammer, and of another special air-driven apparatus fitted with brushes. The necessary operating air is furnished by two portable compressors towed by a caterpillar tractor.

The tapping machine, which runs along on top of the uncovered pipe, is fitted with a series of air hammers that knock most of the rust and other accumulations from the conduit. Any rust, etc., remaining on the pipe after this machine has passed over it is carefully removed by a man armed with the pneumatic hammer. With this done, the surfaces are thoroughly gone over with the brushes so as to prepare them for the application of a protective coating of asphaltic material.



Portable compressors furnish motive energy for special pneumatic equipment used to remove rust from oil pipe lines before the surfaces are given a protective coating of asphaltic material.

HERBERT HOOVER RECEIVES SAUNDERS MEDAL

A YEAR ago William Lawrence Saunders established the Saunders Gold Medal to be awarded annually for "distinguished achievement in mining." The first recipient of the honor was the late D. W. Brunton, who won for himself a conspicuous position in this chosen field of service.

On February 21, during the meeting of the American Institute of Mining and Metallurgical Engineers, the second award of the Saunders Medal was made—Herbert Hoover being the chosen recipient. One has only to recall the many things that Herbert Hoover has done in advancing the art of mining and in bringing numerous properties to profitable productiveness to realize how successfully he has turned waste places in this world into sources of valuable minerals needed for widely diversified purposes. Not only that, but he has given his professional brethren a monumental work in his *Principles of Mining*—a recognized classic in its field.

Finally, for the last seven years, he has been at the head of the Department of Commerce; and, as such, one of his outstanding duties has been that of "fostering mining." Surely Herbert Hoover well deserves the recognition conferred upon him in the presentation of the Saunders Gold Medal.

STONE GUIDEPOSTS FOR THE MOTORIST

THE familiar wooden or metal signs for the guidance of motor traffic are giving way, in England, to markers of stone—which is not only a far more enduring material but one that can be made to beautify rather than to mar the landscape. These signposts, it is reported, are of such a height that the legend they carry will at all times be well within the line of vision of the man at the wheel. This is of outstanding importance, and cannot always be said of the signs in use today. Many of them, when within reading distance, are above the line of sight of the driver; and at night they cannot be seen from the moving car because they are beyond the reach of the headlights.

With these things in mind, an English firm has designed and produced stone guideposts that are said to be effective as well as attractive. The concern in question, according to *Stone*, has developed mechanical facilities that make it possible to cut slabs of standard thickness and also to engrave on them any desired lettering—thus lowering the cost of production.

The annual statistics dealing with the production and the consumption of the world's principal non-ferrous metals, issued by the Metallgesellschaft of Frankfurt, Germany, reveal enormous changes in the relative positions of Europe and America in respect to the output and use of copper, lead, and zinc. Before the war Europe held first place: today the situation is reversed, and America is in the lead.

A new aluminum alloy, called "Aldrey," has been produced in Germany that is said to be especially suitable for power lines because of its tensile strength and its conductivity.

A total of 171,908,000 barrels of Portland cement was produced in the United States in 1927. This, so the Bureau of Mines reports, is a record for the industry, and an increase of 4½ per cent. over the 1926 output.

Stainless steel, which so far has been used principally in the production of cutlery, is being put to service in other fields where it is proving equally satisfactory. For example, painted or kindred lines on streets to guide traffic are giving way to rustless-steel markers that remain bright no matter how wet the weather; and stainless-steel points for fountain pens are the latest thing in Great Britain.

The overseas highway connecting Key West with the mainland has been officially opened. This new automobile route, which winds its way for 129 miles over the keys to Dade County, Florida, was constructed at a cost of $5,000,000.

That industry in the United States values research is brought out by the fact that there are now 1,000 laboratories in the country devoted to investigational work of one kind or another—their number having been almost doubled within the past six years.

An electric furnace has been invented by two pottery experts to take the place of the familiar coal-fired muffle kiln for enamel firing. The new furnace is said to have demonstrated its practicability; and has attracted wide interest among Belgian manufacturers of pottery.

It has been estimated that the potash reserves in Alsace are sufficient to last for from 700 to 800 years at the present rate of production of 12,000 tons per day. The beds are said to contain approximately 1,800,000,000 tons of crude salts, or about 300,000,000 tons of pure potash.

About 5,000 miles of the Pan-American Railway have been completed. This is approximately half of the line as originally surveyed.

Through the secretary of the National Association of Ice Industries the statement has been made that 60,000,000 tons of ice were consumed in the United States in 1927, or 1,040 pounds for every person in the country. This means that in the decade from 1917 to 1927 the per capita demand increased more than 46 per cent.

The 1927 world production of flaxseed is estimated at 160,000,000 bushels, having a value of approximately $350,000,000. These figures may seem large to the layman, especially as the growing of flax just for seed is a comparatively recent field of endeavor. A ton of flaxseed produces from 70 to 80 gallons of linseed oil, for which there is a steadily increasing demand in the manufacture of paints and varnishes, imitation leather, patent leather, linoleum, printers' ink, and many other products.

Civil aviation is being encouraged by the Indian Government, which is planning to construct a chain of aerodromes at various points from Allahabad to Calcutta, a stretch of about 450 miles as the crow flies. The intention is, eventually, to have an aviation field in every cantonment of India.

Statistics reveal that the City of Greater New York has as many if not more inhabitants than the entire Continent of Australia. On July 1, 1926, the population of Greater New York numbered 5,924,000, and the latest census figures, those for June 30, 1927, give Australia 6,178,429.

What is claimed to be one of the largest gold dredges in the world has been put to work on the Lena River in Siberia. According to *The Engineer*, it is electrically driven; is capable of dredging to a depth of 80 feet; and the tailings can be discharged anywhere within a radius of 176 feet. The motors on board have a combined output of 1,335 hp.

The Welland Ship Canal is 78 per cent. completed and, to date, has cost about $90,000,000.

There has recently been discovered in southern Idaho, we are informed by the United States Department of the Interior, a minable bed of manganese oxides that was deposited ages ago in a lake of a glacial period and later covered with about 100 feet of silt. Several teeth of an extinct mammoth gave proof of the remote origin of the bed. Up to May 1, 1927, the deposit has yielded 1,200 tons of high-grade manganese ore.

An extensive deposit of lead and zinc is said to have been discovered about 25 miles from Yarmouth, N. C., by a Canadian geologist and explorer.

Better roads and tires of higher quality at lower prices have done much to reduce the upkeep cost of automobiles. According to the National Automotive Chamber of Commerce, the average tire replacement per car per year has dropped from $82 in 1919 to $34 in 1925. Allowing for a further reduction of $4 in 1926, and using the accepted figures of $33 for repair parts, $45 for service, and $13 for insurance, the outlay for these items is now about $121 per annum.

From 30,000 to 40,000 inquiries concerning the common metals are answered annually by the United States Bureau of Mines.

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—*Founded* 1896—

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EDITORIALS

WHAT INVENTORS HAVE DONE FOR US

WHAT the inventive mind has done for the common good was outlined in a striking way recently by EDWARD J. PRINDLE, president of the New York Patent Law Association, in the course of an address made by him at the annual dinner of that organization. According to Mr. PRINDLE, inventors, by reason of the patent system, have been the primary means of making the United States foremost among all nations in agriculture, in invention, and in manufacture. And, according to him, fully two-thirds of all the inventions of outstanding importance made since the establishment of our patent system have originated with American inventors.

Prior to 1790, when the first patent law was written into our statute book, American farmers employed rather primitive methods; but thereafter the tiller of the soil was supplied gradually with machinery that enabled him greatly to increase his crops. In the early days of the nation one man could cultivate only a few acres; but today with the apparatus at his disposal, one man can work successfully 250 acres.

The inventor has also given us rock drills and air compressors—mechanical aids that have completely revolutionized mining and quarrying and the excavating of rock for numerous purposes. The protection of the patent system has inspired those creative minds that have provided us with the telegraph, the telephone, and the radio in its various applications. And the system has also made it worth while for the inventor to produce the airplane, the submarine, and the ubiquitous motor car.

As Mr. PRINDLE expressed it: "The dreams of Aladdin and Jules Verne pale in the light of these actual accomplishments. Because of the increased productibility which the American inventor has made possible, the average American workman has an attractive home, electric light, a bath, an automobile, a radio, and a victrola, as well as the leisure to enjoy them, notwithstanding he has to compete with cheap labor abroad."

DAVE MOFFAT'S DREAM COMES TRUE

ON the 26th of February trains traveled for the first time through the Moffat Tunnel which pierces the Continental Divide west of Denver. The world at large may not realize the significance of that occasion, but the railroad fraternity of America and the people particularly of Colorado will understand just what that accomplishment represented. It was the climax of fully a quarter of a century of struggle against physical and financial difficulties that were dreadfully disheartening at times but never great enough to halt DAVE MOFFAT or those that followed in his footsteps with the will to do the thing that he had first conceived.

MOFFAT'S purpose in organizing, in 1902, what was known as the Denver, Northwestern & Pacific Railroad, was to link Denver and Salt Lake City by a railway route that would be considerably shorter than those of already existing transcontinental lines. To make this possible, he planned to drive a tunnel through the Continental Divide, but lacking sufficient capital—and time being vital to his enterprise—he pushed ahead and carried his road by a winding course of steep grades over Rollins Pass, at an altitude of 11,660 feet above sea level, where the wind often blows at the rate of 90 miles an hour and the whirling snow forms drifts many feet deep. It has been computed that fully 40 per cent. of the operating cost of the Moffat line was incurred in battling with snow blockades; and train schedules, even with short trains, have been seriously upset throughout the rigorous months of winter.

The Moffat line never got farther than Craig, Colo.; but at one point it is within 42 miles of the Denver & Rio Grande Western which follows a circuitous route of 174 miles from Dotsero to Denver. The construction of the Dotsero cut-off will connect the two railroads and enable them to utilize the Moffat Tunnel for their mutual advantage and to the benefit of the peoples of Utah and Colorado.

The Moffat Tunnel is 6.09 miles long; it shortens the run across the Continental Divide by 23 miles; it lowers the climb by 2,406 feet; and the steepest grades do not exceed 2 per cent., whereas the road over the pass has at points gradients of 4 per cent. Furthermore, a single locomotive will now be able to pull a 22-car freight train from Tabernash, at the west of the crest, to Denver at twice the speed heretofore possible with four engines.

Work on the Moffat Tunnel was started immediately after the contract was signed in July of 1923; and the associate pioneer or water tunnel, as it was called, was holed through on February 18, 1927—the holing through of the final barrier between the east and the west headings in the main tunnel following later on. That the tunnel was finished so that trains could pass through it on February 26 of the present year indicates how rapidly the contractor advanced after encountering sound rock.

It is a matter of record that unstable ground and inundating water gravely hampered operations from time to time, necessitating very heavy timbering, the utilization of special facilities, and the well-nigh ceaseless exercise of care and a high degree of engineering skill. The project could never have been carried through at the cost involved and within the interval required but for the services rendered by rock drills and compressed air. The Moffat Tunnel is a monument not only to Dave Moffat but likewise to every man that has helped to make its completion possible.

PRESIDENT ASKS PUBLIC TO SAVE FORESTS

A NATIONWIDE observance of American Forest Week has been urged by President COOLIDGE; and the week of April 22-28 has been set apart for that purpose—the object being to promote "public discussion of our forests and of what must be done to safeguard and to restore them." Before we can successfully rehabilitate our forests, effectual steps must be taken to minimize fire hazards directly traceable to human carelessness. Whether or not man may be able to prevent forest fires due to lightning has yet to be determined; but measures can be employed that will restrict the spread of fires so started.

Probably what is most needed is a wholehearted response on the part of the people towards any movement contributing to conservation through the careful cutting of mature trees and the incidental protection of other trees in the process of growth to marketable or utilizable lumber sizes. With this idea of use and protection properly rooted in the public mind, it will not be hard to stimulate the practice of replanting lands suitable for the growing of timber; and once we recognize—as they do widely abroad—that timber can be considered in the light of a crop, even though it may take years to reach maturity, then we shall have a grasp of the real economic significance of our woodlands.

Our forests can be made the most of not by rigid preservation alone but by careful and systematic utilization of the natural resource. But in order that we may carry out this policy, we must take prompt measures looking to the safeguarding of stands of timber now remaining and to the recreation of other stands upon lands that have been cut over more or less ruthlessly.

Apart from the manifest advantages that can be derived from an ample supply of wood, we must not forget that timberlands are the native haunts of wild life of many sorts, and that the forest has its reflex also upon the life within the streams that have their source in or flow through the forest. And no one with any appreciation of beauty can be unmindful of the charm that woodlands add to any landscape.

Finally, if we do not conserve our forests we shall presently be face to face with a desperate shortage of high-quality domestic timber.

FREE PORTS TO BE STUDIED BY SHIPPING BOARD

ONCE again the subject of free ports in the United States is under consideration by governmental authorities. This time, the United States Shipping Board is reviving the matter with a view to promoting the American mercantile marine.

Whenever free ports are mentioned, reference is made sooner or later to that outstanding example of this aid to promotion of foreign commerce represented by the free port of Hamburg, Germany. Germany levies more or less heavy duties upon a great many raw and imported finished products, and yet the free port of Hamburg constitutes a capacious reservation within which partly manufactured commodities can be entered duty free and there repacked or brought to a final manufactured stage for direct export—German workmen and German business concerns putting the goods in shape for export. This not only gives the domestic manufacturer or handler a chance to make money and to compete with the foreign producer, but also gives employment to a greater number of German workers and offers an increased opportunity of service to the German merchant marine. What Germany has accomplished through the medium of the free port of Hamburg has inspired other ports and other countries to provide similar facilities; and, as far as we know, all these have been of benefit to the ports and to the nations concerned.

There are ample reasons for the belief that free ports could be established at strategic points on our own seaboards and make it profitable for American manufacturers to rework or to put in final form for export a variety of products that otherwise would be subjected to duty if brought into the country and handled in the usual way, even though intended ultimately for distribution in foreign trade. If other nations have found free ports a means of promoting both commerce and the use of their own ships, why should we not do the same thing and profit likewise?

The administration of free ports presents no insurmountable difficulties; and experience has proved that it is probably easier to prevent the smuggling of dutiable commodities into a country through a free port than it is to achieve the same end throughout the expansive waterfront of any sizable port. In brief, the free port is merely a temporary halting place for imports that are to be shipped abroad immediately after they have been made ready for export by a certain measure of work performed upon them by native labor.

ECONOMIC INSTITUTIONS, by Willard L. Thorp, Professor of Economics in Amherst College. A book of 306 pages, published by the Macmillan Company, New York City. Price, $1.50.

BROADLY stated, economics may be described as a study of the processes whereby society attempts to satisfy the wants of its members. And from the point of view of the individual—depending upon how he meets circumstances—it is the study of why and how he gets as much or as little as he does and why some others get even more or less. Mr. Thorp has the happy gift of presenting lucidly the pros and cons of his subject; and he has dealt with our economic institutions under four heads—namely, machine technique, the price system, private property, and business enterprise. He says: "It is the purpose of this book to examine the economic order now existing in the United States. We must examine each of the four institutions at work. We must examine the facts and consider alternatives. Only then can we understand and attempt to pass judgment on our current economic system."

INDUSTRIAL AND COMMERCIAL SOUTH AMERICA, by Annie S. Peck, A. M., F. R. G. S. A volume of 489 pages, published by Thomas Y. Crowell Company, New York City. Price, $3.50.

Industrial and Commercial South America was first published in 1922, and the reception of the book by bankers, commercial men, and experts in trade relations, etc., has inspired the author to bring out the present revised edition. Miss Peck is widely recognized as a well-informed authority on many aspects of South America, and she has written sympathetically and understandingly after an intimate study of that part of the western hemisphere. Her primary desire was to aid in making us better acquainted with our neighbors to the south for the double purpose of promoting greater friendliness and closer business relations. As far as possible, Miss Peck has presented the latest government statistics available; but these figures are not always up to date simply because some of the governments concerned are dilatory in publishing them. Even so, there is a wealth of informative material in the book, thus making it both an entertaining and an authoritative work of reference.

STANDARDS AND TESTS FOR REAGENT AND C. P. CHEMICALS, by Benjamin L. Murray. A book of 560 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $5.00.

THIS is the second edition of a work that first appeared in 1920. In the earlier edition, the author concerned himself exclusively with standards and tests for reagent chemicals, and the present volume brings this phase of the subject up to date and includes, besides, much thoroughly new material having to do with chemically pure chemicals. The purpose of the latter part of the book is to clarify a condition that has confronted consumers, dealers, and manufacturers, who have heretofore held widely differing views as to what the expression "C. P." really means. The author has provided methods of testing that may be counted upon greatly to diminish this confusion—tests that can be made by the manufacturer or by the consumer with the facilities usually at his command.

THE ROMANCE OF THE COTTON INDUSTRY IN ENGLAND, by L. S. Wood, M. A., and A. Wilmore, D. Sc., F. R. G. S. An illustrated book of 288 pages, published by the Oxford University Press, American Branch, New York City. Price, $2.00.

THE present book has been written for the general reader and for those more or less directly interested in the evolution of the cotton industry in England; and to this end technical details have been purposely avoided. The story is an absorbing one because it is the record of the growth of a graft—at first weak and insignificant—made on that sturdy industrial stem, the ancient woolen industry of England. How that graft has prospered is told in a fascinating manner by the authors; and a reading of the work will make it clear how the cotton industry of England developed and reached its present splendid proportions even though it has had to draw upon far-off countries for its essential raw staple. We heartily commend this book to any and all that may be interested in this subject—a subject that concerns every one of us sooner or later.

THE SHIP UNDER STEAM, by G. Gibbard Jackson. An illustrated book of 262 pages, published by Charles Scribner's Sons, New York City. Price, $3.50.

THE productions of the fertile minds of the modern naval architect and the marine engineer have been changing so rapidly in the last 25 years that but relatively few of the general public are aware of the magnitude and of the amazing character of the progress made. Ships that now dominate the mercantile fleets of the world were declared impracticable if not technically impossible three decades ago; and many ships that would have been considered extremely large craft a quarter of a century back are now looked upon as of minor importance. Therefore, Mr. Jackson has prepared for the layman an instructive and entertaining record of vessels under steam from their beginning to their present climax. Incidentally, he has told something about the first appearance of the iron ship and the evolution of various types of steam-driven battle craft.

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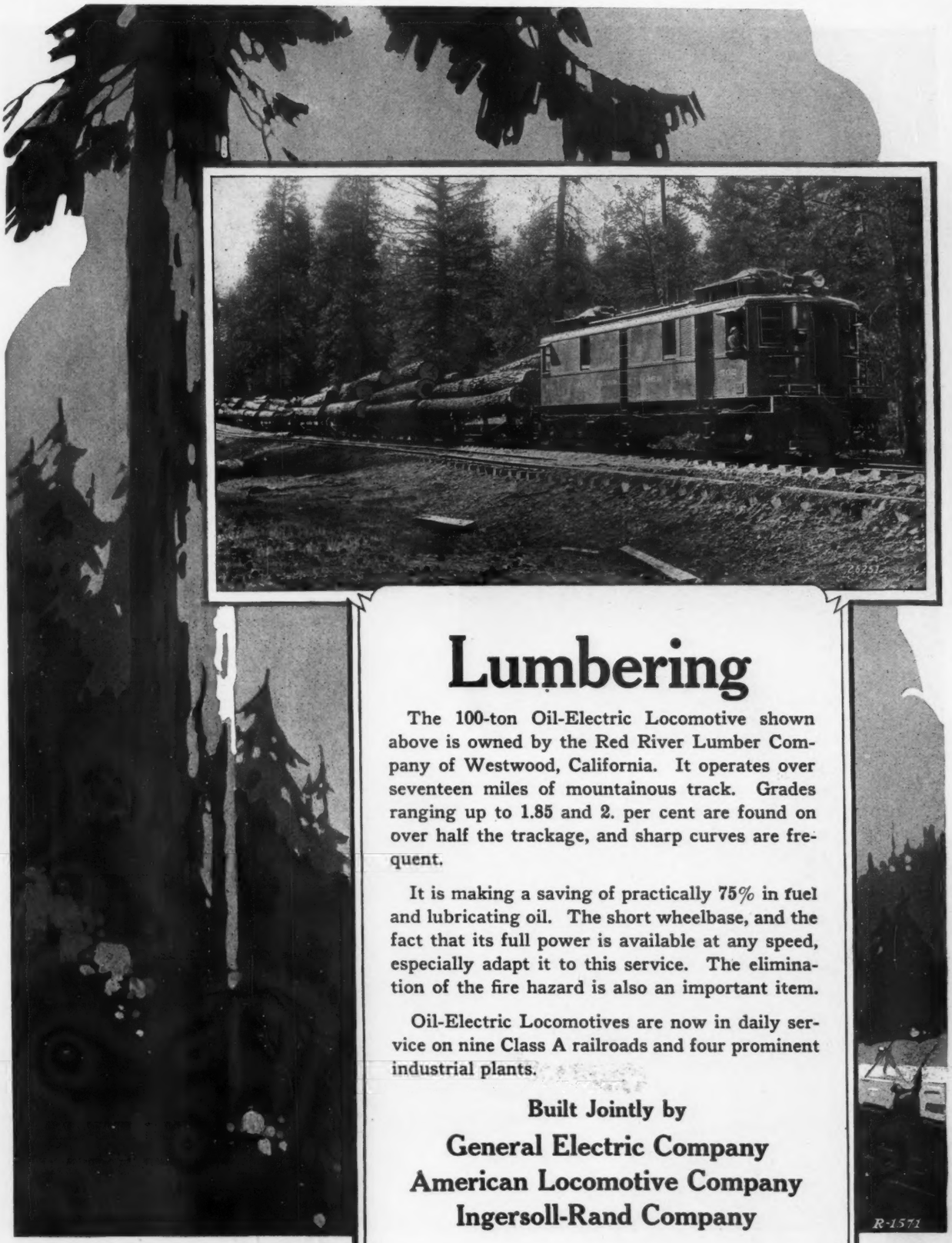

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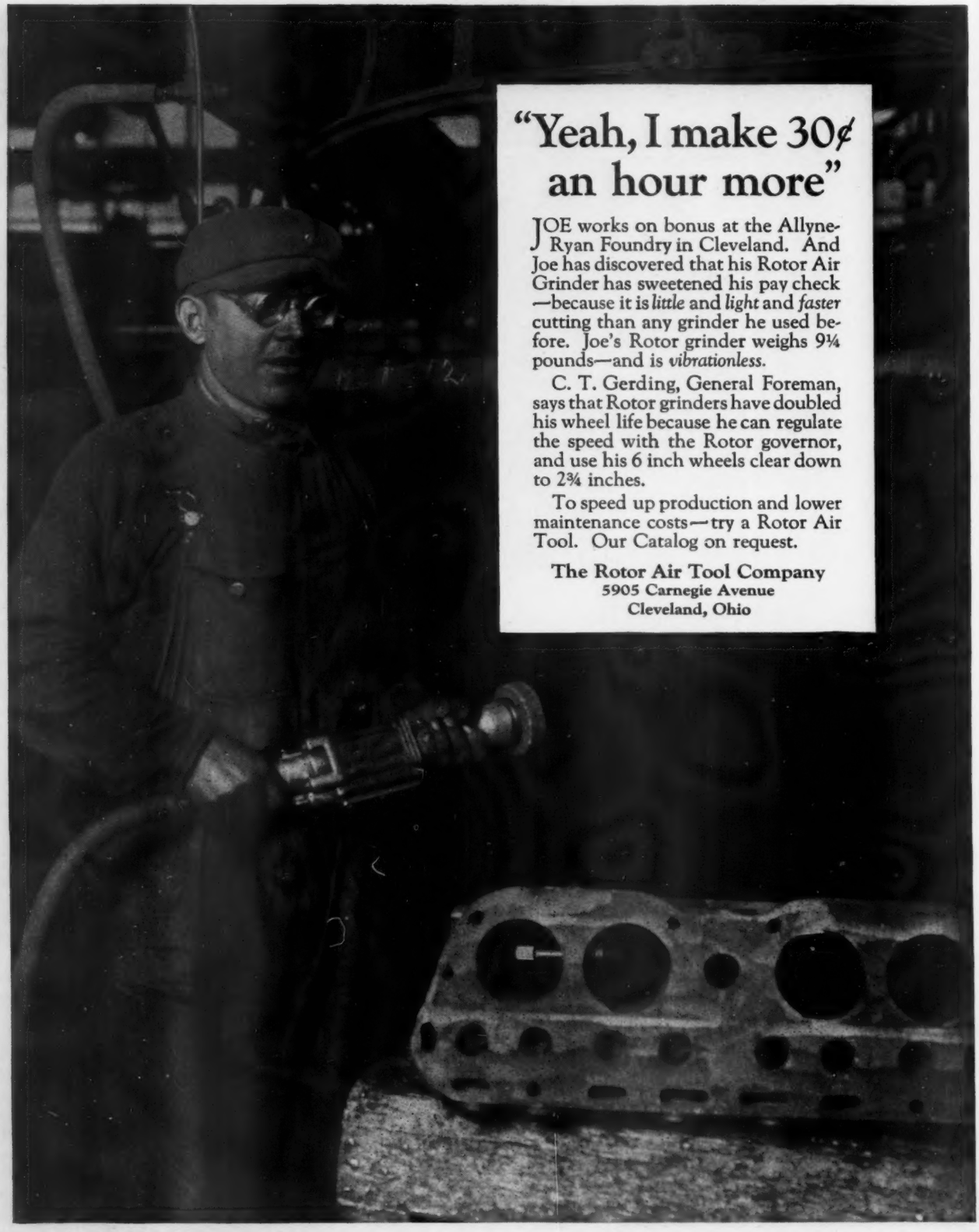

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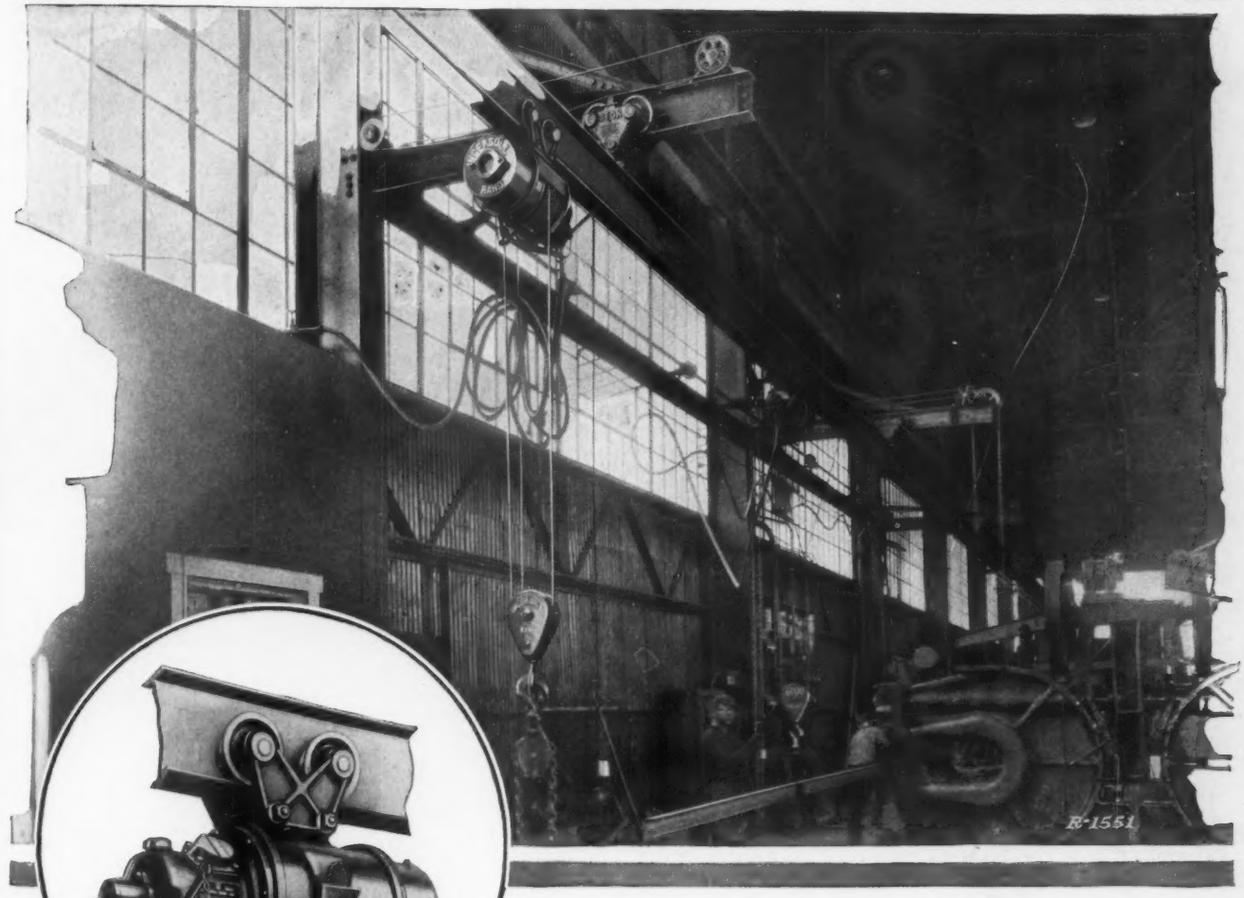

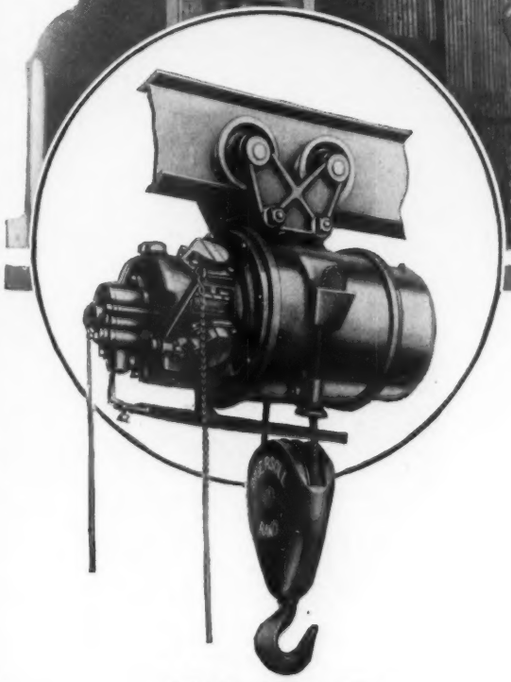

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